THE UNIVERSITY OF ALBERTA

AN INVESTIGATION OF LATERAL DOMINANCE, LEFT-RIGHT DISCRIMINATION AND READING ACHIEVEMENT OF CHILDREN IN THE SECOND YEAR OF SCHOOL

by

© BESSIE MAY ANNAND

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE

OF MASTER OF EDUCATION

DEPARTMENT OF ELEMENTARY EDUCATION

EDMONTON, ALBERTA

FALL, 1971

UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled "An Investigation of Lateral Dominance, Left-Right Discrimination and Reading Achievement of Children in the Second Year of School", submitted by Bessie May Annand in partial fulfilment of the requirements for the degree of Master of Education.

ABSTRACT

This study investigated the relationships between reading achievement and each of: left-right discrimination and lateral dominance in a sample of fifty-seven children in the second year of school. A further investigation explored the relationships of these abilities with certain verbal and visual-perceptual abilities.

This study also provided repeated measures data to add to Smith's (1970)* data so that an additional indication of the longitudinal development of lateral dominance and left-right discrimination, as well as the relationships of these factors to gains in reading achievement, might be ascertained. The lateral dominance characteristics, left-right discrimination abilities, reading achievement, and verbal and visual-perceptual abilities of these children, as measured by certain tests in May, 1971, were compared with the same abilities as tested in May, 1970, by Smith. This study, then, provided additional data on a particular sample of children.

The pupils in the sample were tested using tests of: left-right discrimination, lateral dominance, oral and silent reading ability, and verbal, visual-perceptual and intellectual ability.

This longitudinal-type study revealed that in the second year of school pupils who were able to discriminate

the left and right sides of their own bodies and who knew the meaning of the verbal labels for left and right scored significantly higher in reading achievement than those who could not. When verbal or intellectual ability were covaried out, however, the difference in reading achievement scores between these two groups only approached significance. Pupils with high verbal or high intellectual ability were able to compensate for any disadvantages in reading to which left-right discrimination deficits might have contributed.

A significant relationship between lateral dominance and reading achievement was found, with left-handed children scoring significantly lower than right- or incomplete-handed children. The lower intellectual ability of the left-handed pupils in this sample may have contributed to their lower reading scores.

There was a significant relationship between lateral dominance and left-right discrimination in the present study. A significantly greater proportion of left-handed pupils than right- or incomplete-handed pupils could not consistently identify their left and right lateral body parts.

There were a number of changes in the relationship among the various abilities which were investigated in both 1970 and 1971. Implications of the findings were stated and suggestions for further research were made.

---

*John W. A. Smith, "Left-Right Discrimination, Lateral Dominance and Reading Achievement in Grade One Children" (unpublished Master's thesis, University of Alberta, 1970).

ACKNOWLEDGEMENTS

The author wishes to express her gratitude to all who assisted her in this project and especially to:

Dr. Jean E. Robertson, Committee Chairman, for her invaluable guidance and assistance during the planning and preparation of this thesis.

Dr. W. T. Fagan, Dr. John Paterson and Dr. Myer Horowitz, members of the Committee, for their interest and helpful suggestions.

Mr. Dan Precht and his associates in the Division of Educational Research Services at the University of Alberta and Dr. W. G. Cathcart for their assistance with the statistical procedures used in this study.

The principals, teachers and children of the Edmonton Public School District for their courtesy and cooperation during the process of data collecting.

My husband, George, and children Edith, Evelyn, David and James, for their constant support and encouragement during the preparation of this thesis.

Mrs. Vivian Wenger for her cheerful cooperation in the typing of this thesis.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

THE PROBLEM

When people read in English it is important that they move their eyes from left to right across a page of print and from line to line down the page. Various factors affect a child's facility in reading with this left to right and downward line by line progression and the concomitant reading achievement. One such factor may be the establishment of lateral dominance, that is, a preferred use of one side of the body for motor tasks. A second factor may be the child's ability to discriminate left from right on his own body and on objects and persons in his environment.

The problem was that it was not known whether lateral dominance and left-right discrimination were significantly related to reading achievement in young children. This uncertainty existed because the results of reported research in these areas could not be directly compared for various reasons.

Both lateral dominance and left-right discrimination have been found to be significantly related to reading achievement under certain circumstances, but not under others. Some normative studies, (Harris, 1957; Belmont and Birch, 1963), delineated the age at which these abilities became better developed in certain samples of children.

However, while the relationships of lateral dominance and left-right discrimination to reading achievement in various populations have been widely investigated, very few longitudinal studies concerning this relationship have been carried out.

Less research concerning the relationship of left-right discrimination to reading achievement than of lateral dominance to reading achievement has been reported; again there have been few longitudinal studies. As early as 1963, however, Belmont and Birch suggested that this was an area where further research, especially with children in the contemporary cultural milieu, might provide additional valuable data regarding causes of low reading achievement in some children.

Regarding lateral dominance and reading achievement, the research literature appears to be divided about equally between researchers who used subjects chosen from a reading clinic population and those whose subjects were drawn from the regular school population. In general, if the subjects were chosen of a reading clinic population, lack of established lateral dominance, or the preferred use of eye, hand, and foot on one side of the body, was found to be significantly related to reading achievement. That is, children who had crossed dominance, especially those who were right handed and left-eyed were found more often in the reading clinic population than children with established lateral dominance. Researchers whose subjects were from a reading

clinic population and who found a significant relationship between low reading achievement and lack of established dominance, include: Dearborn (1931), Monroe (1932), Selzer (1933), Harris (1957), Coleman and Deutsch (1964), and Forness (1970).

On the other hand, if the subjects were chosen from a regular school population the researchers found no significant relationship between lack of established dominance and low reading achievement. Researchers whose studies fall into this category include: Clark (1957), Spitzer, Rabkin, and Kramer (1959), Silver and Hagin (1960), Belmont and Birch (1965), and Smith (1970).

There may be some children who have crossed dominance, for instance crossed hand and eye dominance, and who are low in reading achievement and have been diagnosed in a reading clinic. If these three characteristics were strongly associated with each other then a need for further study in this area would be indicated.

With regard to the relationship of left-right discrimination and reading achievement, results of research in this area are just as equivocal as the results of research regarding lateral dominance and reading achievement. There may be some children who have poorly developed left-right discrimination ability and are low in reading achievement. If these two characteristics were strongly associated with each other, then a need for further study would be indicated.

The differences in the results reported by studies regarding lateral dominance, left-right discrimination and

reading achievement were due mainly to variations in research design among the studies, such as differences in: (1) the instruments used to test lateral dominance, left-right discrimination and reading achievement and; (2) the pupil populations from which the samples were drawn.

Two researchers, Hundleby (1969) and Smith (1970), using children in grade three and grade one respectively from a large urban population, found a significant relationship between children's performance on the Benton Test of Left-Right Discrimination and reading achievement. Harris (1957) also found a significant relationship between left-right discrimination and reading achievement in seven-year-old children from a clinic population, but no significant relationship in nine-year-old children from the same population.

Reporting findings directly opposite to the above researchers, Balow (1963), using grade one children but a very short test of left-right discrimination, found no significant relation. Coleman and Deutsch (1964) testing nine- to twelve-year-old children, Benton and Kemble (1960) using nine-year-old children as subjects, and Silver and Hagin (1960) testing eight- to fourteen-year-olds also found no significant relationship.

The problem, then, as expressed in the research literature, was that it was not known whether lateral dominance and left-right discrimination were significantly related to reading achievement in young children. Hence both lateral dominance and left-right discrimination were

investigated in the present study.

PURPOSE OF THE STUDY

Smith (1970) found that a significant positive relationship between reading achievement and left-right awareness existed in a sample of sixty grade one children in a large urban school system, the Edmonton Public School system. He found, furthermore, that established dominant subjects had a greater degree of left-right awareness than crossed dominant subjects. Smith (1970) concluded that there was no significant relationship between established lateral dominance and reading achievement in his sample. He argued, therefore, that for the children in his sample, lateral dominance indirectly affected reading achievement by virtue of the fact that left-right awareness was dependent upon the development of established lateral dominance, with reading achievement being directly related to left-right awareness. It is not known whether this relationship continues to exist in the same way beyond grade one.

The purpose of the present study, then, was twofold:

1. It investigated the relationship between left-right discrimination and reading achievement, and between lateral dominance and reading achievement, in children in the second year of school. Various aspects of lateral dominance in relation to left-right discrimination were also studied. The nature of lateral dominance and left-right discrimination was examined further by comparing the visual-

perceptual and verbal abilities of children classified according to whether they possessed established dominance, incomplete dominance, established lateral dominance, or crossed dominance, and according to whether they could successfully discriminate left and right.

2. It provided repeated measures data to add to Smith's (1970) so that an indication of the longitudinal development of lateral dominance and left-right discrimination, as well as the relationships of these factors to gains in reading achievement, might be ascertained. The following comparisons were also made: the lateral dominance characteristics, left-right discrimination ability, and reading achievement of these children as measured by certain tests in May, 1971, were compared with the same abilities of these children as tested in May, 1970, by Smith (1970) to determine the developmental trend in their reading achievement in relation to visual-perceptual and verbal ability. This study in this way provided additional data on a particular sample of children.

DEFINITION OF TERMS

These are terms which were used in the hypotheses. Other terms were defined as needed.

1. Children in the Second Year of School were children who had been in school approximately eighteen months, regardless of whether they were in grade one or grade two.

2. Reversal Errors on the Neale Analysis of Reading Ability (the Neale) referred to reading words as if a left-right rotation of letters or words or parts of words had been made. For example, the child read 'b' for 'd', 'saw' for 'was', and 'troper' for 'porter'.
3. Reading Achievement was the children's accuracy score on the Neale; indicated word recognition only; does not include the timed score nor the comprehension score; also called the Neale total score.
4. Verbal Ability was the children's score on the vocabulary subtest of the Wechsler Intelligence Scale for Children (the WISC).
5. Visual Perceptual Ability was the children's scores on the Marianne Frostig Developmental Test of Visual Perception (the Frostig).
6. Terms regarding lateral dominance:
    a. Established Dominance meant the preferred use of hand, or eye, or foot for tasks on the Harris Tests of Lateral Dominance. In this study established handedness was indicated when pupils used one hand for eight or more out of ten of the Harris handedness tests; established eyedness when they used the same eye for the two eyedness tasks; and established footedness when they used the same foot for the two footedness tasks. Established dominance meant

established left- or right-handedness, eyedness, or footedness. Children who did not perform the Harris tasks to criteria were classed as having incomplete dominance.

b. Incomplete Dominance meant lack of established dominance of hand or eye or foot, as measured by the Harris tests. For example, an individual was classified as incomplete with with respect to eyedness if he used different eyes for the two eyedness tasks; incomplete dominant with respect to handedness if he used the same hand for less than eight of the handedness tasks; and incomplete with respect to footedness if he used different feet for the two footedness tasks.

c. Established Lateral Dominance meant having the preferred hand, eye, and foot as measured by the Harris on the same side of the body. People can have left established lateral dominance or right established lateral dominance.

d. Crossed Dominance meant a preferred use of hand, eye, and foot involving more than one side of the body. It meant left-eyed and right-handed or right-eyed and left-handed; it also meant having the preferred foot on the opposite side to the preferred hand, and the preferred foot on the opposite side to the preferred eye, when preferred hand, eye and foot were determined by

the Harris. When only two categories were used in some statistical analyses, for example crossed dominant and established lateral dominance, crossed dominant also included incomplete dominant as suggested by Harris (1958).

e. Consistent Pupils were those who elevated the same hand on the Extensibility test as was their preferred hand for writing as indicated by the Harris; also called consistent extensibility.

f. Inconsistent Pupils were those who elevated a different hand on the Extensibility test than was their preferred hand for writing as indicated by the Harris; also called inconsistent extensibility.

4. Terms regarding left-right discrimination:

a. Confused Pupils were those who scored:

(1) from two to twenty-one on the Benton A

(2) less than the median on the Non-Verbal totals:

(a) twenty-five or less on the totals of subtests A, B, and C (total one)

(b) thirty-three or less on the total of subtests A, B, C, and D (total two).

b. Discriminating Pupils were those who were not confused on the Benton subtests nor on the Non-Verbal totals. They were pupils who scored:

(1) twenty-two, twenty-three, or twenty-four

on the _Benton A_

(2) twenty-six or more on the _Non-Verbal_ total one

(3) thirty-four or more on the _Non-Verbal_ total two.

c. _Consistently Reversing Pupils_ were those who scored: zero or one on the _Benton A_.

HYPOTHESES

In this section research hypotheses based on the results of Smith's (1970) study as well as other studies, are stated. A null hypothesis, so phrased for statistical analysis, follows each research hypothesis.

1. _Research Hypothesis One_

Children in the second year of school who are not confused in discrimination between left and right will be more successful in reading than children who are confused in left-right discrimination.

Null Hypothesis One

A. There is no significant correlation between total scores on the _Neale_ and:

1. _Benton_ subtest and total scores
2. _Non-Verbal_ subtest and total scores.

B. There is no significant difference between the _Neale_ total scores of:

1. Confused, discriminating, or consistently reversing pupils on Subtest A of the _Benton_

(_Benton A_)

2. Confused and discriminating pupils on Subtest B of the _Benton_ (_Benton B_)
3. Confused and discriminating pupils on Subtest C of the _Benton_ (_Benton C_)
4. Confused and discriminating pupils on the _Non-Verbal_ totals.

C. There is no significant difference between the _Benton_ subtest and total scores of pupils who make reversal errors on the _Neale_ and those who do not.

D. There is no significant difference in the _Non-Verbal_ subtest and total scores of pupils who make reversal errors on the _Neale_ and those who do not.

2. _Research Hypothesis Two_

Children in the second year of school who are not confused in discrimination between left and right will score higher on tests of visual-perceptual skills than those who are confused.

Null Hypothesis Two

A. There is no significant correlation between subtest and total scores on the _Marianne Frostig Developmental Test of Visual Perception_ (the _Frostig_) and:

1. _Benton_ subtest and total scores
2. _Non-Verbal_ subtest and total scores.

B. There is no significant difference between the <u>Frostig</u> subtest and total scores of:

1. Confused, discriminating and consistently reversing pupils on the <u>Benton A</u>

2. Confused and discriminating pupils on the:

a. <u>Benton B</u>

b. <u>Benton C</u>

c. <u>Non-Verbal</u> totals one and two (Appendix E).

3. <u>Research Hypothesis Three</u>

Children in the second year of school who are not confused in discrimination between left and right will score higher on tests of verbal ability than those who are confused.

<u>Null Hypothesis Three</u>

A. There is no significant correlation between scores on the vocabulary subtest of the <u>WISC</u> and:

1. <u>Benton</u> subtest and total scores

2. <u>Non-Verbal</u> subtest and total scores.

B. There is no significant difference between scores on the vocabulary subtest of the <u>WISC</u> of pupils who were:

1. Confused, discriminating or consistently reversing on the <u>Benton A</u>

2. Confused or discriminating on:

a. <u>Benton B</u>

b. <u>Benton C</u>

c. _Non-Verbal_ total one and two.

4. _Research Hypothesis Four_

Children in the second year of school who are not confused in verbal left-right discrimination will have a greater competence in non-verbal left-right discrimination than those who are confused.

Null Hypothesis Four

There is no significant correlation between _Benton_ and _Non-Verbal_ subtests and total scores.

5. _Research Hypothesis Five_

Children in the second year of school who do not have established lateral dominance will be no more successful at oral reading than those who do.

Null Hypothesis Five

A. There is no significant difference in the _Neale_ total scores of pupils who have crossed dominance and pupils who have established lateral dominance.

B. There is no significant difference in the _Neale_ total scores of pupils who have incomplete dominance and pupils who have established dominance.

C. There is no significant difference in the _Neale_ total scores of pupils who are consistent or inconsistent.

D. There is no significant difference in the proportion of pupils who have crossed dominance and who make reversal errors and the proportion of

pupils who have established lateral dominance and who make reversal errors.

E. There is no significant difference in the proportion of pupils who have incomplete dominance and make reversal errors and the proportion of pupils who have established dominance and make reversal errors.

6. Research Hypothesis Six

Children in the second year of school who do not have established lateral dominance will show greater confusion in left-right discrimination than those children who do have established lateral dominance.

Null Hypothesis Six

A. There is no significant difference between the test means of the established lateral dominant and crossed dominant pupils on the:

1. Benton subtests and total
2. Non-Verbal subtests and totals one and two.

B. There is no significant difference between the proportion of incomplete and established right- or left- dominant pupils who are:

1. Discriminating, confused, or consistently reversing on the Benton A
2. Discriminating or confused on the:
    a. Benton B
    b. Benton C
    c. Non-Verbal totals one and two.

7. Research Hypothesis Seven

Children in the second year of school who do not have established lateral dominance will score lower on visual-perceptual abilities than those who do have established lateral dominance.

Null Hypothesis Seven

A. There is no significant difference in the *Frostig* subtest and total scores of pupils who have:

1. Crossed dominance and pupils who have established lateral dominance
2. Incomplete dominance and pupils who have established dominance
3. Consistent extensibility and pupils who have inconsistent extensibility.

8. Research Hypothesis Eight

Children in the second year of school who do not have established lateral dominance will score no lower on verbal ability than those who do have established lateral dominance.

Null Hypothesis Eight

A. There is no significant difference in the *WISC* vocabulary scores of pupils who have:

1. Crossed dominance and pupils who have established lateral dominance
2. Incomplete dominance and pupils who have established dominance
3. Consistent extensibility and pupils who have

inconsistent extensibility.

9. Research Hypothesis Nine

Children in May of the second year of school will score higher than they scored in May of the first year of school on the following: (1) the Neale total score; (2) the Frostig subtests and total score; (3) the Benton subtests and total score; (4) the Non-Verbal subtests and total score; and (5) the WISC vocabulary subtest score.

Null Hypothesis Nine

A. There is no significant difference between pupils' scores in May of the first year of school and in May of the second year of school on the following:

1. Neale total score
2. Frostig subtest and total scores
3. Benton subtest and total scores
4. Non-Verbal subtest and total scores.
5. WISC vocabulary subtest and total score.

10. Research Hypothesis Ten

The proportion of children who are: (1) established dominant; (2) established lateral dominant; (3) consistent; and (4) discriminating will be greater in the second year of school than in the first year of school.

Null Hypothesis Ten

There is no significant difference between the

proportion of pupils in May of the second year of school and the proportion in May of the first year of school who are:

1. Established dominant
2. Established lateral dominant
3. Consistent
4. Discriminating.

OVERVIEW OF THE STUDY

In this repeated measures study a sample of fifty-seven children from a large urban school system, the Edmonton Public School system, in the second year of school were tested to determine the state of their lateral dominance, whether established, crossed, or incomplete. The ability of these children to discriminate left and right was also tested. The children's reading achievement level was determined and statistical tests were carried out to determine the significance of the relationship amongst these three elements. In addition, the various aspects of lateral dominance were compared with certain visual-perceptual abilities and verbal abilities of these children to determine what relationship existed among these factors.

The present researcher found fifty-seven of the sixty children who comprised the sample in Smith's (1970) study. These children were still in elementary schools in or near the city of Edmonton. The three who were not included in the 1971 sample had moved 180 miles or more

from Edmonton.

The testing was conducted in April and May, 1971, and was carried out by the present researcher. The following tests which were used by Smith (1970) were administered first, the:

(1) Neale Analysis Test of Reading Ability (Form A) (the Neale);

(2) Harris Tests of Lateral Dominance (the Harris); (Appendix A)

(3) Extensibility Test (the Extensibility); (Appendix B)

(4) Benton Test of Right-Left Discrimination (the Benton); (Appendix C)

(5) Non-Verbal Test of Directional Orientation (the Non-Verbal); (Appendix D)

(6) Wechsler Intelligence Scale for Children, vocabulary subtest (the WISC);

(7) Marianne Frostig Developmental Test of Visual Perception (the Frostig);

The Lorge-Thorndike Intelligence Tests, Level two, Form A, Primary Battery (the Lorge-Thorndike) used in the present study, but not used by Smith (1970) was administered last. A fourth subtest, D, was added to the Non-Verbal and was administered after subsection A, B, and C (Appendix D). The Gates-MacGinitie Reading Test, Primary B, Form One (the Gates-MacGinitie) was administered by the classroom teachers in June.

A pilot study using four children was carried out

prior to the main study to determine the effectiveness of subtest D on the Non-Verbal.

The present researcher administered and marked all of the tests, except the Gates-MacGinitie. All of the tests, except the Frostig, the Lorge-Thorndike, Level Two, and the Gates-MacGinitie, were given individually and in random order as determined by a table of random numbers (Keeping and Kenney, 1954). The Frostig and the Lorge-Thorndike, Level Two, were given in groups of nineteen or less. The Gates-MacGinitie was given and marked by the teachers in the various schools in June, 1971. To facilitate comparison of the 1971 and 1970 test results, the children were assigned the same identification numbers as used by Smith (1970).

ASSUMPTIONS

It was assumed that:

1. All of the children in the sample had been taught so that any reading deficiencies shown by the children in the sample were not due to teacher inadequacies.

2. Any behavior problems which would have adversely affected the pupils' learning to read were normally distributed throughout the sample of children.

3. Any disabilities, such as articulatory deficits, were normally distributed.

LIMITATIONS

1. A limitation of this study was that all of the

children were no longer grouped in three classrooms as they were in the Smith (1970) study. Eight children were in eight other schools. It was not possible to assess the effect of teacher interaction, nor the emotional and socio-economic factors which may have prompted the families of these children to change residence, upon these children's reading achievement.

2. Another limitation of this study was that it was not known whether the three children who 'dropped out' of the sample of children tested in April and May constituted a particular subgroup or if they had a particular common characteristic which would have altered that subgroup's performance.

3. It is known that five of the children who were excluded from the analysis of data using the Gates-MacGinitie, Primary B, scores because they were repeating grade one were among the lowest achieving readers in 1970. It is not known how they would have ranked in 1971 had they been tested on the Gates-MacGinitie, Primary B, rather than on the Primary A; since the Primary A is not an alternate form of the Primary B results on these two tests are not directly comparable.

4. The nature of the Non-Verbal test is still a limitation. This experimental test, which was designed by Smith (1970) and to which the present researcher added another subtest, lacks established reliability. Hence the results of the Non-Verbal test should be considered as

tentative.

5. The nature of the Extensibility test was also a limitation. It was used in this study as described by Smith (1970) who followed the method of Silver and Hagin (1960) who in turn extrapolated from Hoff and Schilder (1927) who reported in German. No English translation of the work of Hoff and Schilder (1927) was available at the initiation of the experiment.

SIGNIFICANCE

This study probed the relationship between lateral dominance and left-right discrimination and the reading achievement of a certain sample of children in the second year of school. It also probed the relationship between these children's lateral dominance and left-right discrimination ability and their status on tests of visual perception and verbal ability.

1. There may be then some relationships among lateral dominance and left-right discrimination and reading achievement that is typical of children in the second year of school. If these patterns could be discerned in the present study it might be possible for classroom teachers and reading clinicians to identify and assist children who needed help.

2. The added data provided by this study on the sample of children who were tested by Smith (1970) in the first year of school could be the beginning of a longitudinal-type study. By gathering additional data on the same

children in their second year of school, using the same testing instruments, and extending the analysis of the data to compare the children's performance in two consecutive years, it was possible to accumulate a sizeable collection of data on a certain sample of children in the Edmonton Public School system.

Some of the characteristics which showed no significant change in a one-year period might show a change over a two-year period thus identifying a different pattern. Therefore, the same method of collecting data in these children could be followed again another year, so that a pattern of development in this sample of children over several years might be discerned.

3. This study through testing the lateral dominance, left-right discrimination and reading achievement of a sample of children in the Edmonton Public School system may give additional information on testing instruments which could be used to further delineate the problems of children with reading difficulties.

SUMMARY

The problem was that it was not known whether lateral dominance and left-right discrimination were significantly related to reading achievement in young children. This uncertainty existed because the results of reported research in these areas could not be directly compared for various reasons.

A significant relationship between lateral dominance and reading achievement was generally reported by researchers who used a sample from a clinic population. On the other hand, researchers using samples from a regular school population generally found no significant relationship.

There may be some children who have crossed dominance, for instance crossed hand and eye dominance, and who are low in reading achievement and have been diagnosed in a reading clinic. If these three characteristics were strongly associated with each other then a need for further study in this area would be indicated.

Regarding left-right discrimination and reading achievement the relationship seemed to depend upon the age of the children. In six-, seven-, and eight-year-olds the relationship was found to be significant by several researchers. In nine- to twelve- and fourteen-year olds several researchers reported that the relationship was not significant.

There may be some children who have poorly developed left-right discrimination ability and are low in reading achievement. If these two characteristics were strongly associated with each other, then a need for further study would be indicated.

The purposes of this study, then, were to:

1. Investigate the relationship between lateral dominance and reading achievement and between left-right discrimination and reading achievement of children in the

second year of school. The relationships among various aspects of lateral dominance, left-right discrimination, visual perception and verbal ability were also investigated.

2. Provide repeated measures data to follow up Smith (1970) so that an indication of the longitudinal development of lateral dominance and left-right discrimination, as well as the relationships of these factors to gains in reading achievement, might be ascertained.

The terms used in the hypotheses were defined in Chapter I, and the hypotheses were presented.

The sample of children for this repeated measures study consisted of fifty-seven children in the second year of school in a large urban school system. These fifty-seven pupils were still in elementary schools in or near the city of Edmonton. The three pupils not included in the present study had moved to centres more than 180 miles from the city.

All of the pupils were tested individually on the Neale, the Harris, the Extensibility, the Benton, the Non-Verbal, and the WISC vocabulary subtest and in groups of nineteen or less on the Frostig and Lorge-Thorndike, Level Two by the researcher. Classroom teachers administered the Gates-MacGinitie, Primary B.

It was assumed that all of the children had been well taught and that the emotional stability and articulation ability of the children in the sample were homogenous enough that any differences would not significantly affect the

children's reading achievement. Limitations of the study were cited.

Regarding significance of the study, there may be some dominance characteristics and some left-right discrimination characteristics that are typical of children in the second year of school who have low reading achievement. If these patterns could be discerned in the present study it might be possible then for classroom teachers and reading clinicians to identify and assist these children. This study also provided longitudinal-type data on certain children over two successive years.

CHAPTER II

REVIEW OF THE RELATED LITERATURE

In this chapter selected literature regarding lateral dominance, left-right discrimination, and cerebral dominance will be reviewed. This literature forms the backdrop of the present study. The chapter was divided into three sections:

1. The relationship of lateral dominance to reading achievement
2. The relationship of left-right discrimination to:
    a. Lateral dominance
    b. Reading achievement
3. The relationship of cerebral dominance to:
    a. Lateral dominance
    b. Left-right discrimination
    c. Reading achievement

For the reader's convenience summaries and tables at the end of each section of this chapter contain the salient points.

Various relationships among these factors have been found by the many researchers who have probed the problem, hence there are many theories regarding the importance of lateral dominance, left-right discrimination, and cerebral dominance in relation to reading achievement, depending upon

which findings the theories are based.

It is not known if any of these three factors actually cause reading disability. If there is a possibility that they do, however, researchers have concluded, steps should be taken to teach the child in a manner that would take the best advantage of laterality characteristics and left-right discrimination abilities (Monroe, 1932; Selzer, 1933; Betts, 1936; Witty and Kopel, 1936; Monroe and Backus, 1937; Clark, 1957 and 1959; Kephart, 1960; Dechant, 1964; Roswell and Natchez, 1964; Jansky and Langford, 1966; Harris, 1970).

Though the ideas of lateralization, or preferred sidedness, and left-right discrimination appear to be simple, they are, nevertheless, very complex (Hécaen and de Ajuriaguerra, 1964, p. 130). The equivocal results of research in these areas support this statement. The gaining of knowledge about the importance of these two factors in reading achievement has been further complicated by a third factor, the idea of cerebral dominance, that is, of a controlling cortical hemisphere for language functions (Hécaen and de Ajuriaguerra, 1964, p. 3).

LATERAL DOMINANCE AND READING ACHIEVEMENT

The results of studies on the relationship between lateral dominance and reading achievement fall into two categories:

1. Studies showing a significant relationship

between these two factors

2. Studies showing no significant relationship between them. In general, though not always, a significant relationship was found if the sample in the study had been chosen from a reading clinic population. Conversely, but not invariably, no significant relationship was found in samples of children in the study chosen from a normal school population. This pattern of results suggested that some basic neurological deficiency may have been the cause of the most severe cases of reading retardation.

The studies using a sample of clinic cases which were reviewed by the present researcher, are very good examples of some of the better research which has been done on lateral dominance and reading achievement. Hence they were pertinent to the present study in that they were models for the design of the present study. Furthermore, they alerted the present researcher to the possibility of some underlying neurological disturbance, as a cause of severe reading retardation.

Since only a small proportion of the total school population is seriously retarded in reading, the lateral dominance characteristics of the most seriously retarded readers did not appear as significant in relation to the mean reading score of the whole group in studies which used a sample of children from a normal school population. This did not show conclusively, however, that the lateral dominance characteristics of these children were not significant factors in their reading achievement. Testing the lateral

dominance and reading achievement of children in a normal school population would pick out the children who were the lowest in reading achievement and who had some of the lateral dominance characteristics found significant in children in reading clinics. This combination of low reading ability and anomalies of dominance would signal the immediate need for further study of these children. Hence a sample of children from a normal school population was selected for the present study.

Furthermore, some researchers have found that lateral dominance characteristics change with age (Gesell and Ames, 1947; Harris, 1957; Belmont and Birch, 1963); the relationship between lateral dominance and reading achievement could also conceivably change with age. Since the present study is a longitudinal-type study, tests of lateral dominance were included to see if the lateral dominance characteristics and their relation to reading achievement had changed significantly in one year's time.

Studies on Samples from a Clinic Population

Monroe (1932) in a study designed to examine the relationship between dextrality and reading ability chose a sample of 415 children who had been referred to her reading clinic. She compared the results of these children with the results of 101 children chosen from the regular school population to form a control group. The mean chronological age of children classified as reading defective clinic cases was

eleven years seven months and their mean intelligence quotient was 89.6. The mean chronological age of children in the control group was eight years four months; their mean intelligence quotient was 111.4. Monroe stated that she chose younger subjects for the control group so that they would be at about the same stage in learning to read as the reading defective cases. She recognized that the control group was probably slightly above normal in intelligence due to her method of selection.

Monroe administered four items to test handedness and one item to test eyedness. She gave six reading achievement tests as follows: The Gray Oral Reading Paragraphs; the Haggerty Reading Examination; the Monroe Silent Reading Examination; the Iota Word Test; the Diagnostic Reading Test; and the Stanford Achievement Test in Reading. Monroe found a high positive correlation among the six reading tests.

In comparing lateral dominance and reading achievement Monroe found no significant difference between the number of reading defective cases who were left-handed and the number in the control group who were. This concurs with Clark (1957). Monroe did, however, find a significant difference between the number of reading defective cases who showed crossed dominance of the type where they were right-handed and left-eyed and the number of the control group who showed this characteristic. She also found that the reading defective cases had more reversals in their reading regardless of their laterality.

In conclusion Monroe suggested that having opposite hand- and eye-dominance might impede coordination of directional responses such as are required in reading in that the child who is left-eyed may adapt more easily to stimuli in the left field of vision and may thus have a tendency to move his eyes toward the preferred field. Because of the interference to the line of vision by the nose Monroe argued that it may be more difficult for left-eyed children than for right-eyed children to learn the progressive left-to-right eye movement that is required in reading.

In writing, Monroe asserted, the child who has established dominance, either right or left, will have the same directional preference, while the child with crossed dominance may have conflicting directional preferences, which may thus cause difficulty in developing accurate space perception, another ability which is necessary for successful reading achievement.

The main criticism of this study would be the small number of laterality tests used to determine handedness and eyedness. Many other possible causative factors in reading disability were examined in the Monroe study, however, and laterality was not the central theme.

Dearborn (1931) also subscribed to the same theory as Monroe, seeing the tendency of left-eyed children to move their eyes right-to-left as causing confusion regarding letter sequence compared with sound sequence. This, he postulated, leads to confusion and a slowing-down of the word

recognition process. Dearborn's sample of children consisted of one hundred clinical cases who had extreme difficulty in learning to read. His control group was from an unselected public school population. The ages, intelligence quotients, hand dominance tests, and reading tests are not recorded in the 1931 report of the study. To test eyedness Dearborn used a stereoscopic method of determining eye dominance as devised by Selzer. In the clinic group Dearborn found a preponderance of children who were described as: (1) left-eyed; (2) having lack of established hand-dominance; or (3) as having mixed hand-eye dominance. He did not find this in the control group. Dearborn's findings led him to conclude that these factors negatively affect reading achievement.

Harris (1957) used a sample of 316 children with severe reading disability from a reading clinic population, ranging in age from seven years to over eleven years and having an intelligence quotient of eighty or more. He compared the performance of these children with that of a sample of 215 children, chosen from the regular school population in a large urban area. The purpose of his study was to give evidence that there is a significant relationship between some facets of lateral dominance and reading disability. He used the 1955 Harris Tests of Lateral Dominance to test the children's laterality characteristics. The children's reading ability had been previously assessed. Harris found a significant relationship between lateral

dominance and reading disability. In the clinic population, at age seven and age nine, there were significantly more children of mixed dominance than in the normal school population at the same age ($p<.01$). By age nine, the percentage of children showing mixed, or incomplete, hand dominance and left-handedness was much lower in both groups, but the proportion of children with these characteristics was significantly higher in the reading disability group ($p<.01$). Contrary to Monroe and Dearborn, Harris found no significant relationship between crossed dominance and reading achievement at any age level in either group. The difference in these results may have been due to the fact that each of these researchers used different tests of laterality. Harris did not describe which reading tests were used and did not report the mean or the range of the intelligence quotients of the children in the control group.

Harris (1970) presented a detailed discussion of the theoretical relationship between lateral dominance, directional confusion and reading disability. Harris (1970, p. 242) also noted the discrepancies in the results of many studies regarding lateral dominance and reading achievement and lists several reasons for these conflicting results. He cited two recent reviews of studies on lateral dominance: (1) Zeman (1967) and (2) Weintraub (1968). Harris criticized these reviewers for not including any studies from the medical literature. He also pointed out several sources which described and critically reviewed tests of lateral dominance

other than the Harris Tests of Lateral Dominance. These sources were: (1) Clark (1957); (2) Johnston (1942); (3) Hécaen and de Ajuriaguerra (1964); and Selzer (1933). Other sources describing tests of lateral dominance are Silver and Hagin (1960) and Critchley (1964, p. 52).

Forness (1970) quoted Zangwill as suggesting that it might be advantageous to determine what types of poor readers are ill lateralized. Forness therefore selected a sample of seventeen boys from a population of twenty-six boys on a perceptual motor program at the University of California at Los Angeles. These boys had normal verbal intelligence, but were retarded more than two years in reading. They ranged in age from eight and one half years to ten years of age and had a mean age of nine years three months. Forness gave each child the Gray Oral Reading Paragraphs, the Peabody Picture Vocabulary, and the Harris Tests of Lateral Dominance. A pediatric neurologist examined each child; thirteen of the subjects were diagnosed as having minimal brain dysfunction. Sixteen of the children were right-handed and did not differ significantly from a control group of unselected school children.

Forness therefore concluded that right- or left-hand dominance had no relationship to reading achievement. He did, however, find a significantly higher incidence of crossed dominance among the children in the clinic sample. The more severely retarded readers had a noticeable tendency to be left-eyed. The results of the Forness study concurred

with those of Monroe and Dearborn. Forness did not state the level of significance of either relationship and did not give the ages nor the intelligence level of the control group.

Two of the selected clinic sample studies, Silver and Hagin (1960) and Capobianco (1966), did not show a significant relationship between any aspects of lateral dominance and reading achievement. The lack of significance in the results, however, may have been due to their research design or to the special characteristics of the population from which the sample of children who were retarded readers was drawn.

Silver and Hagin (1960) tested thirty children drawn from a population of 150 children from a mental hygiene clinic and a private medical practice. These children had originally been referred because of behavior problems. The method of selecting the sample was not given. The ages of the children in the sample ranged from eight years six months to fourteen years; their intelligence quotients were from eighty-one to 123. The proportion of boys and girls is not given. A control group matched for age, sex, and intelligence quotient and selected from the same population was used for comparison on the various tests administered. The children were thoroughly diagnosed, neurologically and perceptually.

In the neurological area, the children in Silver and Hagin's study were given a classical neurological examination,

plus: (1) tests of left-right discrimination; (2) tests of handedness, eyedness, and footedness; (3) extension of the arms, a test devised by Schilder; (3) "postural reflexes", a test devised by Hoff and Schilder; (5) a fine movements test; and (6) fifteen of the children were tested by electroencephalogram. In the perceptual-integrative field the children were given selected tests of certain visual-motor, auditory, tactile, and drawing-a-person abilities. The tests included the Bender Visual-Motor Gestalt Test, the marble test of Crain and Werner, and certain sections of the Monroe Auditory Discrimination Test, the Gates Reading Diagnostic Test, and the Durrell-Sullivan Reading Capacity Test.

In relation to this section of the present study, Silver and Hagin (1960) reported: (1) no significant difference in hand preferences between the retarded readers and the control group; (2) no significant differences in eye preference between the two groups; and (3) no significant difference in mixed eye and hand, foot and hand, or eye and foot preference. Mixed hand, eye, or foot dominance in Silver and Hagin's (1960) study was taken to mean crossed dominance by the present researcher. The levels of significance were not given. Findings two and three were contrary to those of Monroe (1932) and Dearborn (1931). This discrepancy may be due to the difference in the tests of laterality used by these different researchers or to differences in the population from which the sample was selected. The results of other tests pertinent to the present study, those

of left-right discrimination and cerebral dominance, will be reported later in this chapter.

In the present study the children in the sample were given a gross screening for evidence of emotional problems through an informal set of questions (Appendix F). No such problems were noted. In addition, the questions were designed to set the child at ease for the individual testing session.

The clinic population from which Capobianco (1966) drew his sample of fifty-eight retarded readers was also atypical; the people chosen for the study were enrolled in the Johnstone Training and Research Centre at Bordentown, New Jersey, a day-school for the mentally retarded. Their chronological ages ranged from 12.9 to 17.5 years; the mean mental age was 9.6 years. Intelligence quotients of the group as measured by the Wechsler Intelligence Scale for Children ranged from 44 to 89; their reading achievement level ranged from grade 1.2 to 6.9. He used four tests of handedness and four tests of eyedness to determine laterality. He measured eye acuity with the Orthorater. Capobianco divided the sample into established dominance and not established dominance groups, then compared the reading achievement of the members of each group as measured by the Wide Range Achievement Test. He found no significant difference in reading achievement between the established and not established groups within this sample. This is contrary to Monroe (1932) and Dearborn (1931).

One reason for the discrepancy between the results of Capobianco (1966) and other clinic population studies, such as Monroe and Dearborn, may be that Capobianco selected his subjects from a population of mental retardates, while the former researchers tested children from a reading clinic population. Another reason for the conflicting results may be the differences in criteria for determining the classification of a child as established or not established, used by the various researchers. Furthermore, Capobianco did not discriminate between various types of laterality as did Monroe and Dearborn who found a significantly higher number of left-eye dominant children amongst the reading clinic population.

In the present study the level of intelligence of children in the sample was ascertained through administering the <u>Lorge-Thorndike</u>, Level Two. The children all scored eighty-two or more, so none of them could be classified as mentally retarded.

Additional useful information was sought about children who have these three characteristics concurrently:

1. Are low in reading
2. Have crossed dominance, for instance, crossed hand and eye or crossed foot and eye
3. Have been diagnosed in a reading clinic.

Hence studies of children from a reading clinic population were reviewed in the present study.

<u>Summary</u>. The research studies reviewed above

indicated that even when the studies were narrowed to include only studies based on tests of samples of children selected from clinic populations the results were equivocal. The causes of the above noted discrepancies in the results included:

1. Differences in the characteristics of the clinic populations from which the sample was selected

2. Differences in the tests used to determine laterality

3. Differences in criteria used to classify the children in the studies as established or not established in dominance.

Additional information was sought about children who have been diagnosed in a reading clinic and who have anomalies of dominance. Hence studies from a reading clinic population were reviewed in the present study.

The above studies were summarized in Table 1.

<u>Studies Using Samples from a Regular School Population</u>

Clark (1957), one of the leading authorities on laterality and its relation to reading achievement in British children presented a comprehensive summary and critical analysis of what she considered to be some of the more important studies on lateral preference. Clark began her book with a discussion of whether handedness was genetically or environmentally determined. She concluded that the two crucial questions, 'Why is the majority of people right-handed?' and 'How does an individual acquire handedness?'

Table 1

Summary of Studies on the Relationship Between Lateral Dominance and Reading Achievement in a Clinic Population

Researcher	Tests	Sample	Relationship to Reading	Criticism
Monroe (1932)	4 handedness items; 1 eyedness item; Gray Oral Reading; Monroe Silent Reading; four other reading tests.	405 clinic reading disability cases; mean age 11 years 7 months, mean IQ 89.6. Control, 101 normal school children; mean age 8 years 4 months; mean IQ 111.4.	Significant; level not given.	Small number of tests used to determine handedness and eyedness.
Dearborn (1931)	A stereoscopic method to measure eye dominance; hand dominance tests not given. No reading test.	Reading clinic group; ages, IQ, numbers, not given. Controls, not described.	Significant level not given.	Ages, IQ's of control group not given.

Table 1 (continued)

Researcher	Tests	Sample	Relationship to Reading	Criticism
Harris (1957)	_Harris Tests of Lateral Dominance_ No reading test.	316 reading clinic cases; median age 10 years; IQ 80 or more. Controls, 245 unselected children, 7 and 9 years old; IQ not given.	Significant; Age 7: $p<.01$ Age 9: $p<.01$	Reading tests not described. IQ of controls not given.
Harris (1970)			A detailed discussion of the theoretical relationship between lateral dominance, left-right discrimination, and reading.	
Forness (1970)	_Harris Tests of Lateral Dominance_; _Gray Oral Reading Test_; _Peabody Picture Vocabulary_.	Clinic group, mean age 9 years 3 months, average intelligence. Controls, ages not given	Significant; level not given.	IQ's and ages of controls not given.

Table 1 (continued)

Researcher	Tests	Sample	Relationship to Reading	Criticism
Silver and Hagin (1960)	Extensive neurological tests; laterality tests of handedness, eyedness, and footedness.	Group of 30 from reading clinic; Controls, 30 children from same population, matched for IQ, sex, and age, 8 years 6 months to 14 years; IQ 81 to 123.	Not significant. Level not given.	Difference between clinic group and control group not clear; they seem to be from the same clinic population. Very few tests of handedness.
Capobianco (1966)	4 tests of handedness; 4 tests of eyedness; Wide Range Achievement Test for reading score.	58 mental retardates enrolled a full-day program at a research centre.	Not significant. $p > .05$	The clinic population from which sample was selected was atypical; it was not a reading clinic population.

were not satisfactorily answered by environmental theories. The geneticists, on the other hand, admitted that factors other than heredity help to determine handedness. The findings of Hunt (1966) also supported this statement.

In looking at the developmental aspect of laterality Clark cited a number of studies which she felt showed conclusively that hand and eye preferences were established in almost all children before school age. Clark asserted that her evidence discounted the view that school writing instruction determined handedness and negated the theory that left-handedness is the result of rebellion against school authorities.

Belmont and Birch (1963) in their study of 148 children aged five to twelve years also found that at age five the children in their sample showed very little mixed dominance. However, at ages six, seven, and eight a high percentage of mixed dominance was found in their sample of children. By age ten, however, Belmont and Birch again found a low percentage of mixed dominance in their sample of children.

Gesell and Ames (1947) in their longitudinal study of forty-five children from infancy to age ten years also found this fluctuation between right- and left-handedness and mixed dominance up to the age of ten years when they became either right-handed or left-handed.

In her 1957 study Clark tested 330 eleven- and twelve-year old children in Primary VII classes in eight Glasgow

schools to determine the degree and type of laterlality characteristics in these children. All children in the study had previously been tested on a Group Intelligence Test and on Achievement Tests which are normally given to all children in Scotland at the end of the Primary Stage of their schooling. Clark used a battery of eighteen tests to examine every possible aspect of lateral dominance in these children. She found no significant difference in the achievement of children who were established right- or left-handed. However, right-handed children with left-handed tendencies, that is, incomplete dominance, achieved significantly poorer than right-handers. Clark concluded that lack of established dominance was a possible cause of directional confusion which then lead to poor word recognition and hence to lower reading achievement. To Clark this finding implied that beginning school children should be measured for hand dominance and then trained to use their dominant hand properly in writing and other fine motor movements (Clark, 1957 and 1959).

Clark divided her 1970 study into three stages, namely: (1) Part One, which was a data gathering survey on a group of 1,544 seven-year-old school children in a county near Glasgow, Scotland; (2) Part Two, which was a study of 230 of these children who were having difficulty with reading two years later, at age eight years, that is, all the backward readers from the original sample; and (3) a further analysis of those children of average intelligence who

continued to have difficulties with reading at age nine years. Part One of Clark's 1970 study was the most relevant to the present study, so only that part will be discussed in detail here. The sample for Part One was comprised of 1,544 children, 791 boys and 753 girls, from the primary grade school population of a county near Glasgow, Scotland. The children were all seven years of age and had completed two years of schooling.

Each child in the sample was given the following tests: (1) the Schonell Graded Word Reading Test; (2) the English Picture Vocabulary Test (EPVT); (3) a test to measure the level of motor coordination which was based on a section of the Stanford-Binet Intelligence Scale, Form L-M; (4) a series of tasks to determine hand, eye, and foot dominance. The tasks to determine handedness were to observe which hand the child used to write his name and in drawing the above designs; the child was also asked to throw a ball into a basket on three attempts and the hand used was noted; to determine footedness, the foot used on three attempts at kicking a ball was noted; to determine eyedness the child was required to look through a hole in the centre of a piece of cardboard, held at arm's length, and say how many fingers the examiner was holding up and the eye used to sight was noted; and (5) five instructions to measure knowledge of left and right; the instructions were those used in the Isle of Wight Survey, as follows: (i) point to your nose with your left hand; (ii) point to your left ear with your

right hand; (iii) point to my left hand (tester being opposite child); (iv) point to my right hand (tester's arms are crossed); (v) point to the wall on your left.

Clark (1970) found that 236 children were at only the earliest stages of learning to read. This was 15.3 percent of the total group. The proportion of boys (18 percent) was higher than the proportion of girls (12.5 percent); Clark did not say if the differences were significant. With regard to lateral dominance, Clark found that 10.9 percent of the boys and 6.5 percent of the girls were left-handed. She stated that this showed an apparent increase in left-handedness in contemporary school children and thus warned against making comparisons with the results of dated studies of children of different ages or environment. The sex difference in left-handedness was also significant; level of significance not given. Left-eyedness was found in 33 percent of the children. Clark found no significant difference in the reading quotient for any laterality characteristics, whether the child was left-handed, left-eyed, mixed or incomplete dominant, or crossed dominant. This finding concurred with Stevenson and Robinson and Douglas, Ross and Cooper as quoted by Clark (1970), and with Balow (1963), Coleman and Deutsch (1964), Belmont and Birch (1965), and DeHirsch, Jansky, and Langford (1966). These researchers also used samples of children from normal school populations.

Witty and Kopel (1936) investigated the relationship between reading achievement and various conditions of

laterality drawing their sample from the two thousand children in the public school population in Evanston, Illinois. The experimental group was made up of the one hundred children in the population who scored the lowest in reading on the Metropolitan Achievement Test. There were sixty boys and thirty-four girls with intelligence quotients of 80 or above in this group. The mean intelligence quotient was 96. The ages of the group ranged from seven years and four months to fourteen years and seven months; the mean age was ten years and four months. The control group was made up of one hundred children of intelligence quotient 80 or above whose scores on the Metropolitan Achievement Test was at or above their grade norms. They were matched as closely as possible to the experimental group in age, sex, and intelligence quotient. There was a similar proportion of boys and girls in the control group; their ages ranged from seven years and four months to twelve years and four months. The mean intelligence of the control group, 104, was slightly higher and their mean age, nine years and two months, was slightly lower than the experimental group. Witty and Kopel administered twenty-two items, which were adapted from Koch, to measure handedness and three items to measure eyedness. Witty and Kopel found a slightly higher incidence of right-handedness among the problem readers than among the normal readers. They also found that hand preference had no significant relationship to reading achievement in that there was no greater incidence of crossed nor mixed

dominance in the experimental group than in the control group. They also found that eye dominance, whether left or right, was not related to reading achievement. These findings are contrary to Dearborn (1931), Monroe (1932), Harris (1957) and Forness (1970), who used samples from a clinic population. However, the findings of Witty and Kopel concurred with those of Robinson (1953), Clark (1957 and 1970), Spitzer, Rabkin and Kramer (1959), Balow (1963), Balow and Balow (1964), Coleman and Deutsch (1964), Hillerich (1964), Belmont and Birch (1965), Boos (1970), and Smith (1970). All of these researchers tested the lateral dominance characteristics of children from a normal school population.

Koos (1964) on the other hand found that there was a relationship between mixed dominance and reading achievement in a sample of 109 primary grade children in a middle socio-economic urban school. The relationship was significant in the group which had a mean intelligence quotient of under 125. It was not significant in the group with a mean intelligence quotient of over 125. This would indicate that children with superior intelligence were able to compensate for any anomalies of dominance and hence their reading achievement would not reflect the effects of these anomalies. Children of average or below intelligence were not so able to compensate, hence scored lower in reading achievement.

As their reading disability group, Spitzer, Rabkin, and Kramer (1959) used a sample of 103 children, ages nine years to thirteen years, from the population of 1,900

students in the normal school population of Roselle, N.Y. These children were chosen because they were in remedial reading classes and were achieving in reading at least one year below their general intellectual level. Spitzer et al. used the children's scores on the Wide Range Achievement Test or on the California Reading Test as criteria for inclusion in the reading disability group. In general, the intelligence quotient of the reading disability group, as measured by the Stanford-Binet Test or by the Wechsler Intelligence Scale for Children, was lower than that of the control group which was chosen from the same population. The control group consisted of 288 children, ages five to thirteen years, who were not in remedial reading classes. The method of selection was not given. The reading disability group contained 78.6 percent boys, while the control group was half boys and half girls. To test lateral dominance the children in both groups were given three items for handedness and one item for eyedness. Spitzer et al found that there were not significantly more children with mixed dominance in the reading disability group than in the control group. They concluded, therefore, that lateral dominance was not significantly related to reading achievement; the level of significance was not given. It is not clear from the report of this study whether or not the Wide Range Achievement Tests and California Reading Test were given to all the children at the time of the study. Furthermore, very brief tests of lateral dominance were given.

Balow (1963) tested 302 grade one children from a suburban school using the Harris Tests of Lateral Dominance; the Gates Reading Readiness Tests; the Gates Primary Reading Tests, PWR-Word Recognition and PPR-Paragraph Reading; and Lorge-Thorndike Intelligence Tests, Level One. Balow found no significant relationship between lateral dominance and reading achievement ($p>.05$) when intelligence was covaried out. Balow tested lateral dominance in September and reading achievement at the end of February. His findings are therefore qualitatively different from findings by other researchers in this area. Balow was really testing lateral dominance as a predictor of reading achievement rather than testing the relationship between these two factors at any one given time.

Balow and Balow (1964) tested 250 children still remaining in the same district from their 1963 sample. These children were now in grade two. The Harris Tests of Lateral Dominance (the Harris Tests) were administered to those children who had not had established dominance in 1963. The Gates Advanced Primary Reading Tests, Word Reading and Paragraph Reading, were given to all children in the sample in February. The intelligence quotient scores were obtained from the Lorge-Thorndike Intelligence Tests, Level One, which these children had been given in grade one. As for grade one children, Balow and Balow concluded that there was no significant relationship ($p>.05$) between lateral dominance and reading achievement in grade two children. The main criticism

of this study was that Balow and Balow missed an opportunity to look at fluctuations in the lateral dominance characteristics of their sample of children from one year to the next. Gesell and Ames (1947) and Belmont and Birch (1963) all found that laterality fluctuated between left- and right-hand preference for as long as until up to age ten. Clark (1957) asserted that laterality was firmly established by age five years. Balow and Balow could have provided additional data from a longitudinal-type study on this fluctuation or lack of fluctuation of laterality had they given the Harris Tests to all of the children in their 1964 study, but they made no further study of laterality.

Coleman and Deutsch (1964) tested 114 public school children from a low socio-economic area, mostly Negro children, using tests from the Harris Tests of Lateral Dominance and the Gates-McKillop Reading Diagnostic Tests. They found no significant relationship between lateral dominance and reading achievement in this group of children who ranged in age from 9.5 years to twelve years.

Belmont and Birch (1965) tested 150 children drawn from the entire population of children in a single birth year in the city of Aberdeen, Scotland. These children, all boys, with a mean age of nine years and nine months and whose reading score was in the lowest ten percentile made up the retarded readers group. A second group, composed of boys matched for age and with reading scores above the lowest ten percentile, was selected as a control group. Belmont

and Birch compared dominance characteristics both between and within the retarded and normal readers groups and found no significant difference in the amount of mixed dominance between the retarded readers and the normal readers. This was a well-designed study.

Hillerich (1964) in a three-year longitudinal study had 520 children from a kindergarten in an urban area in his original sample. Of these, four hundred children remained three years later. The children were given two eye-dominance tests with five trials on each. In kindergarten they were given one hand dominance test, the tapping test, which Hillerich considered involved a minimum of social learning. A second hand dominance test, which involved connecting dots with each hand was added in grade two. A fifty item reversal test was given in grade one and grade two. On the basis of the grade two dominance tests the children were divided into five groups. Their reading achievement in grade three was measured using the <u>California Achievement Test</u>, Form W, Upper Primary Level. Hillerich found a higher incidence of confused hand dominance in grade two than in kindergarten, and a decrease in the amount of incomplete eyedness among the children in grade two as compared with grade one. Hillerich also found no significant relationship between dominance characteristics and intelligence, reversal errors or reading achievement in this group.

Boos (1970) replicated the Hillerich (1964) study using the 277 students from Hillerich's original kindergarten

sample when these people were in grade seven and eight. Boos used the same dominance tests as Hillerich, but added four more tests of handedness. Boos also measured the children for controlling eye in binocular vision, as contrasted to the dominant eye used in sighting, by means of the Keystone Telebinocular. Reading achievement was tested using the Reading Achievement Test, Form W, Junior High Level, of the California Short-Form Test of Mental Maturity; intelligence scores were also based on a sub-test of this test. Boos, contrary to Hillerich, found a great increase in mixed dominance amongst these children in grade eight, thus showing a trend toward ambidexterity and ambieyedness with increasing age. Boos found no significant relationship between any type of lateral dominance and reading achievement or sex of the child. He also found no significant relationship between crossed control, that is, where the controlling eye and dominant hand are on opposite sides, and unilateral control. Boos used a more thorough test of lateral dominance than Hillerich. Also, his attention to 'controlling' eye in binocular vision is an interesting addition to the dominance controversy.

Smith (1970) tested the lateral dominance of sixty normal grade one children using tests from the Harris Tests of Lateral Dominance. The children represented a cross-section of a large urban population and had a mean age of six years and 11.68 months. Smith also tested: reading achievement, using the Neale Analysis of Reading Ability;

left-right discrimination, using the <u>Benton Tests of Right-Left Discrimination</u>; verbal ability, using the vocabulary section of the <u>Wechsler Intelligence Scale for Children</u>; and visual perception, using the <u>Frostig Developmental Test of Visual Perception</u>. Smith, like preceding researchers who tested children from a regular school population, found no significant relationship between any type of lateral dominance and reading achievement. The children in Smith's sample were well tested regarding lateral dominance and reading achievement; both the tests which he used have established reliability.

The lateral dominance characteristics of the lowest achieving readers in a normal school population may be significant factors in their low reading achievement. Testing the lateral dominance and reading achievement of children in a normal school population would pick out the children who were the lowest in reading achievement and who had some of the lateral dominance characteristics found to be significant in children in reading clinics. This combination of low reading and anomalies of dominance would signal the immediate need for further study of these children. Hence studies regarding the relationship of lateral dominance characteristics to reading achievement in a normal school population have been reviewed in this chapter.

<u>Summary.</u> In general, studies which used samples of children drawn from a normal school population found no significant relationship between any type of lateral

dominance characteristics and reading achievement.

Since only a small proportion of the total school population is seriously retarded in reading, the lateral dominance characteristics of the most seriously retarded readers did not appear as significant in relation to the mean reading score of the whole group in studies which used a sample of children from a normal school population. This did not show conclusively, however, that the lateral dominance characteristics of these children were not significant factors in their reading achievement.

Children who have anomalies of dominance and are poor readers may also possess some other characteristics which would warrant further study. Hence the above studies were included in this review of the literature.

Studies using samples from a normal school population were briefly summarized in Table 2.

THE RELATIONSHIP OF LEFT-RIGHT DISCRIMINATION TO LATERAL DOMINANCE AND READING ACHIEVEMENT

Left-Right Discrimination and Lateral Dominance

Left-right awareness, or the ability to distinguish left from right in one's own body schema and in people and objects in the environment, is viewed by psychoneurologists as being developmental in nature. Interest in left-right orientation of children who are retarded readers has arisen from the assumption that maturation of the ability to distinguish right from left on their own bodies is a prerequisite for a correct spatial orientation of objects and

Table 2

Summary of Studies on the Relationship Between Lateral Dominance and Reading Achievement in a Normal Population

Researcher	Tests	Sample	Relationship to Reading	Criticism
Clark (1957)	18 tests of various aspects of laterality.	302 children from the Primary VII class of Glasgow, Scotland, schools. Age range 11 to 12 years. Matched for IQ and sex.	Not significant if right-handed or left-handed. Significant if had left-hand tendencies. $t = 2.46$ $p<.05$	A well designed study. Testing of lateral dominance very thorough.
Gesell and Ames (1947)	Longitudinal study; tests of hand dominance.	45 children from infancy to 10 years of age.	Hand dominance fluctuated among mixed, left, and right-hand preference. Stabilized at age 10.	A well designed study.
Clark (1970)	Schonell Graded Word Reading Test; English Picture Vocabulary Test; test of motor coordination; tests of dominance.	1,544 children; primary grade school population county near Glasgow, Scotland; seven years old.	Not significant for any type of laterality.	A well designed study.

Table 2 (continued)

Researcher	Tests	Sample	Relationship to Reading	Criticism
Witty and Kopel (1936)	22 handedness items; 3 eyedness items (Koch). Metropolitan Achievement Tests for reading ability.	100 children from a public school system who scored lowest on the Metropolitan, IQ 80 or above, average IQ 96, average age 10 years 4 months. Controls, 80 children who scored average or above on the Metropolitan, average IQ 104, average age 9 years 2 months.	Not significant; level not given. Reversal errors not significantly related to mixed or crossed dominance.	This design is good. Problem readers somewhat older and lower IQ. Problem readers showed fewer reversals; reversals decrease with age.
Spitzer, Rabkin and Kramer (1959)	3 items for handedness; 1 item for eyedness. Wide Range Achievement Test or California Reading Test for reading ability.	103 children from suburban grammar schools who were in remedial reading classes; ages 9 years to 13 years; IQ on the average lower than the control group. Control group, 288 children from the same schools who were not in remedial reading program; ages 5 to 13 years.	Not significant; level not given.	Very brief tests of lateral dominance. Is not clear if W.R.A.T. and California test were given to all children at the time of the study.

Table 2 (continued)

Researcher	Tests	Sample	Relationship to Reading	Criticism
Balow (1963)	Harris Tests of Lateral Dominance; Gates Reading Readiness; Lorge-Thorndike Intelligence Tests; Gates Primary Reading Test.	302 grade one children from suburban school; mean IQ's of groups equal.	Not significant; $p>.05$	A good study. Lateral dominance and reading well tested.
Balow and Balow (1964)	Harris Tests of Lateral Dominance; Gates Advanced Primary Reading Test.	250 children left from the sample of 1963.	Not significant; $p>.05$	Gave Harris test only to children who did not show consistent directionality preference in grade one.
Coleman and Deutsch (1964)	Harris Tests of Lateral Dominance; Gates Advanced Primary Reading Test; Gates McKillop Reading Diagnostic Tests.	114 children from a low socio-economic area; mostly Negro; ages 9.5 to 12 years old.	Not significant	Concurred with Silver and Hagin (1960), a clinic sample; contrasted Harris (1957), also a clinic sample, but younger.

Table 2 (continued)

Researcher	Tests	Sample	Relationship to Reading	Criticism
Belmont and Birch (1965)	Tests from <u>Harris Tests of Lateral Dominance; Metropolitan Achievement Tests: Reading</u>	150 boys in lowest 10 percentile; age 9 years 9 months; IQ 92.1. Controls: 50 boys not in lowest 10 percentile; age the same; IQ 104.9	Not significant	Compared performance between the two groups and within each group. A well designed study.
Hillerich (1964)	2 eyedness items; 2 handedness items; <u>California Achievement Test</u>. Form W.	Longitudinal study. 520 children from an urban area in kindergarten; 400 children remained three years later.	Not significant $p>.05$ Reversal-test scores not significantly related to dominance.	Only one handedness test used in kindergarten; added a second item in grade two; still a brief test.
Boos (1970)	Replicated Hillerich (1964); used same tests.	Longitudinal study. 277 children in grade 8 remaining from Hillerich (1964) sample.	Not significant; $p>.05$. More mixed and crossed dominance in grade 7 and 8 than in grade 2.	A better test of lateral dominance. than used by Hillerich. His attention to 'controlling' eye in binocular vision was interesting.

Table 2 (continued)

Researcher	Tests	Sample	Relationship to Reading	Criticism
Smith (1970)	*Harris Tests of Lateral Dominance*; *Neale Analysis of Reading Ability*.	60 normal grade one children; cross section urban population; mean age 6 years 11.68 months.	Not significant; $p>.05$	Well tested; both tests reliable.

also for fluent reading, which requires a consistent directionality for quick word recognition (Benton, 1962. In Money, 1962, p. 98).

The development of this left-right awareness is hierarchical in nature, however. Piaget (1928, p. 217) saw the development of left-right awareness as occurring during three periods in a child's life with overlapping at the upper and lower end of each period. The first period, generally completed in a child (in Geneva) by age five years, is the "personal viewpoint" period when the child can name his own body parts and the left and right sides of objects oriented the same way in space as his own body, but cannot name the left and right sides of a person facing him. Piaget's second period, the "viewpoint of others" period extends from five years to eight years when the child develops the ability to adopt the point of view of a person facing him, but cannot take the viewpoint of actual objects in the environment. The third period, the "viewpoint of objects" periods, is reached by most children, according to Piaget, by the time they are eleven years of age. By then the child's egocentrism is overcome to such an extent that he can make accurate relational judgments, Piaget asserted.

Benton (1962, p. 98), saw the same development of left-right awareness, but occurring two or more years later in the child's life than Piaget observed. Benton (1959, p. 132) postulated that the child's rate of progress through these periods depends not only upon maturation, but upon

three additional factors which are: (1) the somasthetic and visual reception of stimuli regarding "own body" discriminations in relation to other people and objects in the environment; (2) learning, which depends upon intelligence, and experience; and (3) the ability to handle symobolic representations in the form of receptive and expressive language.

Benton (1955) found that children of superior intelligence had a level of left-right discrimination ability which was above their chronological age. Conversely, mentally defective children, with intelligence quotients in the forty to seventy-five range, (Stanford-Binet or Wechsler-Bellevue), were strikingly poor in this ability. Their left-right discrimination ability was below what would be expected for even their low mental age.

Regarding the relationship between lateral dominance, a motor function, and left-right discrimination, a perceptual function, theoretical considerations have led some researchers to postulate that the perceptual function of left-right discrimination develops out of the preferential motor usage, that is, the lateral dominance, of one side or the other of the body (Benton, 1959, p. 37). They then hypothesized that if a child has established lateral dominance he would have a higher degree of left-right discrimination. This hypothesis has been tested by several researchers; the results were however, equivocal.

Benton (1959) made normative observations on 158 school children, aged six to nine years, with intelligence

quotients between 85 and 115 and who were attending school in average socioeconomic neighborhoods. He administered the Benton Test of Right-Left Discrimination to each child. In ascertaining the total score on the test Benton gave the children credit for the number of consistent discriminations which they made regardless of whether they made the correct response to the verbal symbols left and right. That is, if a child consistently used his left hand when instructed to use his right hand and vice versa he was given a point for each response. The score recorded was the number of consistent reversals or the number of correct responses to the verbal symbols, whichever was higher. Benton postulated that the child who makes consistent reversals has actually mastered the somatospatial discrimination of left and right, but for various reasons reverses the verbal symbols in relation to the body parts.

Benton (1959) found that left-right discrimination develops progressively throughout the age range of six to nine years. His Table Three (Benton, 1959, p. 27) shows the means and standard deviations of the total score and three subtests scores for each age level. His Table Four (p. 28) shows the percentage of correct responses for each aspect of performance on the right-left- discrimination battery.

Benton (1959, p. 141) found that children who were strongly left-handed or strongly right-handed had a higher level of left-right discrimination than children with

incomplete dominance. Belmont and Birch (1963), on the other hand, found that accuracy of discrimination of children's own body parts occurred two years earlier than their clear-cut established hand preference.

Benton and Menefee (1957) tested a sample of sixty-six normal kindergarten and grade school children aged four years and eleven months to eight years and five months. There were thirty-three boys and thirty-three girls with intelligence quotients ranging from eighty to 137. Benton and Menefee used a thirty-five item battery to test handedness in a variety of activities; they gave no tests of eyedness. They tested left-right discrimination using a sixteen-item battery which involved identifying their body parts and performing certain "crossed" commands both with eyes open and with eyes closed. The children were not penalized if they consistently reversed the commands, that is if they did not have the correct verbal labels, but still could differentiate one side from the other consistently. Benton and Menefee did not test the ability of these children to identify the body parts of another person facing them. Benton and Menefee found a "small positive association" between degree of established dominance and left-right discrimination ($r = .24$, $.05<p<.10$). They concluded that laterality was only a minor determinant of left-right discrimination and asserted that various learning situations probably affected the development of left-right discrimination to a much greater extent.

Smith (1970) tested a sample of sixty grade one

children with a mean age of six years and 11.68 months and an intelligence quotient of over eighty as measured by the Detroit Beginning First Grade Intelligence Test or the Lorge-Thorndike Intelligence Tests, Level One. He used the Harris Tests of Lateral Dominance and the Benton Tests of Right-Left Discrimination to determine the relationship between laterality and left-right discrimination. Smith found that children with established dominance discriminated left and right better than children with crossed dominance ($p<.01$). This finding concurred with Benton (1959) who used the same test of left-right discrimination. Smith found no significant relationship between incomplete and established lateral dominance subjects in their ability to discriminate left and right. Smith's tests of laterality and left-right discrimination were very thorough and yielded more information than the tests used by Benton and Menefee. This may account for the clearly significant relationship which Smith found between these two factors.

Belmont and Birch (1963) in a normative study analyzed the ages at which various types of lateral dominance became established, the age at which left-right orientation became established, and the relationship between these two functions in normal school children. The subjects in this study were 148 children taken from a suburban elementary school for children of normal intellectual ability. The children were in grades kindergarten through grade six and ranged in age from five years to twelve years and five

months. There was an equal number of boys and girls; they did not differ significantly in age, intelligence quotient, and grade placement. The mean intelligence quotient was significantly above that of the general population, according to scores on the Otis Quick-Scoring Test of Mental Ability which were available for all children from grade three through grade six. The children were all tested for lateral dominance and left-right discrimination.

Four items were used to test hand dominance; four items tested eye dominance; and one item tested foot dominance. Belmont and Birch used the three left-right discrimination of own body parts items from the Harris Tests of Lateral Dominance plus four items from the Piaget schedule. In addition they used five questions from Piaget to test knowledge of left and right in a person facing the child and of objects in the environment in relation to each other.

Belmont and Birch (1963) found that 75 percent of the seven years to seven years eleven months old children in their sample were right-handed; 4 percent were left-handed; and 21 percent had mixed hand dominance. Mixed handedness was more pronounced in the six-, seven-, and eight-year old children, than in the nine-to twelve-year-old children ($p<.05$). Very few five-year-olds had mixed hand dominance, a finding which concurred with Clark (1957). The level of mixed eyedness was greater in younger subjects than in older ones. There was a significant difference ($p<.05$) in mixed eyedness between children under ten years of age and

those over ten years of age. They also found a significant difference in ipsilateral hand-eye preference ($p<.02$) between children under ten years of age and those ten years and older. This fluctuation in lateral dominance after age five was also found by Gesell and Ames (1947). Belmont and Birch (1963) found no significant difference in handedness between boys and girls though the girls tended to show more left- and mixed-handedness than did the boys.

With regard to left-right discrimination Belmont and Birch found that age differences in attaining this ability were statistically significant ($p<.001$). Above age seven, 95 percent of the children made correct responses to all seven questions concerned with left-right discrimination of their own body parts. Conversely, below age seven only 69 percent of the children could discriminate their own body parts correctly on this test. By age seven 75 percent of the children in Belmont and Birch's group could also distinguish right-left relations on a person facing them, but not on objects in the environment.

Belmont and Birch (1963) noted that accuracy of left-right discrimination of own body parts occurred two years earlier than clear-cut establishment of hand preference or eyedness and three years earlier than eye-hand consistency in their sample. This finding is in contrast to Benton (1959, p. 141) who found that strongly left- or right-handed children had a higher level of left-right discrimination. Belmont and Birch concluded that lateral dominance and left-

right awareness develop independently of one another. The difference in findings between these two studies may be due to the difference in tests, the Piaget tests versus the Benton tests, used to determine left-right discrimination and the different criteria used to determine established dominance.

There may be some relationship between a child's status as indicated by lateral dominance tests and his left-right discrimination ability. Therefore, studies investigating the relationship between children's lateral dominance status and their left-right discrimination ability were reviewed in this study. Lateral dominance and left-right discrimination were tested in the present study to determine if there were a relationship between them in the present sample of children.

Summary. Three studies, which used the Benton Test of Right-Left Discrimination, or a modification of it, found that there was a significant positive relationship between established lateral dominance and level of left-right discrimination. One study, which used items from the Piaget tests, found that accuracy of left-right discrimination of own body parts preceded clear-cut established hand preference. The discrepancy in results may have been because of the different tests used, or because of different criteria used to determine established handedness.

The possibility exists of a relationship between a child's status as indicated by lateral dominance tests and

his left-right discrimination ability. This relationship may have implications for reading achievement. Therefore, studies investigating the relationship between children's lateral dominance status and their left-right discrimination ability were reviewed in this study.

A summary of the selected studies concerning left-right discrimination and laterality was made in Table 3.

Left-Right Discrimination and Reading Achievement

Regarding the relationship of left-right discrimination to reading achievement, results of research in this area were just as equivocal as the results of research regarding lateral dominance and reading achievement. However, not as much research has been done on left-right discrimination and reading as on laterality and reading. Belmont and Birch (1963) suggested that this was an area where further research especially with children in the contemporary cultural milieu, might be fruitful.

As with lateral dominance, the discrepancies in the results of studies to determine the relationship of left-right discrimination to reading achievement were due mainly to differences in research design among the studies. The differences in design were caused by many factors including: firstly, differences in the instruments used to test left-right awareness and to assess reading ability; and secondly, differences in the populations from which the samples were drawn.

Harris (1957) found a significant relationship

Table 3

Summary of Studies on the Relationship Between Left-Right Discrimination and Lateral Dominance

Researcher	Tests	Sample	Findings
Piaget (1928)		Children in Geneva, Switzerland. Numbers not given.	Development of left-right awareness hierarchical in nature; occurred in three stages with overlapping at upper and lower end (p. 217): (1) "personal viewpoint", by age 5 years; (2) "viewpoint of others", by age 8; (3) "viewpoint of objects", by age 11.
Benton (1962)	Based on his 1959 study.		The same general pattern of development as Piaget, but occurring two years later in the children's lives.
Benton (1959)	<u>Benton Test of Right-Left Discrimination</u>	Normative study on 158 school children; ages 6 to 9 years; IQ 85 to 115.	Left-right discrimination developed progressively throughout the age range (Benton, 1959, Tables 3 and 4, p. 28). Children who were strongly unilateral had a higher level of left-right discrimination. (Benton, 1959, p. 141).

Table 3 (continued)

Researcher	Tests	Sample	Findings
Benton and Menefee (1957)	35-item test of handedness; 16-item test of left-discrimination of own body parts.	66 kindergarten and grade school children; aged 4-11 to 8-5; IQ 80 to 137.	Small positive association between lateral dominance characteristics and left-right discrimination ($.05<p<.10$). Did not measure ability to discriminate left and right on another person.
Smith (1970)	Harris Tests of Lateral Dominance; Benton Test of Right-Left Discrimination.	60 grade one children from a normal school population.	Children with established dominance discriminated left and right better than children with crossed dominance ($p<.01$).
Belmont and Birch (1963)	Tests of hand, eye, and foot dominance; 12 items to test left-right discrimination 5 from the Piaget tests.	Normative study; 148 children from suburban elementary schools; K to grade 6; 5 years to 12 years old; above average IQ.	Contrary to Smith; Benton and Menefee; and Benton. Accuracy of left-right discrimination of own body parts occurred two years earlier than clear-cut established hand preference. Used a different test of left-right discrimination than the three former researchers.

between left-right discrimination and reading achievement at age seven ($p<.01$), but not at age nine. Harris used a sample of 316 children with severe reading disability from a reading clinic population, ranging in age from seven years to over eleven years and having an intelligence quotient of eighty or more. Eighty-seven percent were boys. He compared the performance of these children with that of a sample of 215 children, approximately half boys and half girls chosen from the regular school population in a large urban area. He used the results of the Harris Tests of Lateral Dominance to determine the children's left-right discrimination ability. Harris did not say how he determined the reading achievement of the children in his study. The most striking finding was the high proportion of seven-year-old children in the reading disability group, 38 percent, who showed confusion in left-right discrimination as compared with the proportion of seven-year-old children in the control group who showed confusion. The difference was significant at the .01 level. At age nine there was no significant difference.

The main criticisms of this study were that first, Harris used only three items regarding the child's identification of own body parts to test knowledge of left and right; secondly, he did not say how reading achievement was measured in the control group nor how retarded in reading the reading disability group was; thirdly, he did not give the intelligence quotients of the control group so they might

have been of higher average intelligence than the reading disability group. Since intelligence is a factor in the development of left-right discrimination (Benton, 1959) it seems important to know whether or not the mean intelligence quotients of the two groups is comparable. One of the strongest points of Harris' design was that although his subjects ranged in age from seven years to over eleven years, he divided them into three groups. This enabled him to see developmental trends in left-right discrimination at the various age levels.

Belmont and Birch (1965) also found a significant relationship ($p<.01$) between children's left-right discrimination ability and their reading achievement. Belmont and Birch tested 150 children drawn from the entire population of children in a single birth year in the city of Aberdeen, Scotland. These children, all boys, with a mean age of nine years and nine months and whose reading score was in the lowest ten percentile, were selected as a control group. A British sentence-reading test, Form N.S. 6, published by the National Foundation for Educational Research in England and Wales, and three parts of the Metropolitan Achievement Test, Elementary Battery Form B: Test 1, Word Knowledge; Test 2, Word Discrimination; and Test 3, Reading, were used to assess reading ability in all of the children.

All subjects in the study had intelligence quotients of eighty or above as determined by the Wechsler Intelligence Scale for Children. The difference in mean intelligence

quotients between the retarded readers (92.1) and the normal readers (104.9) was significant at beyond the .01 level of confidence. The difference in the reading ability of the two groups was significant at beyond the .001 level of confidence. The children's awareness of left and right was tested using the three questions on left-right discrimination of own body parts from the Harris Tests of Lateral Dominance and nine questions derived from Piaget (1928). The Piaget questions concerned knowledge of left and right of own body parts, of a person facing the child, and of objects in the environment in relation to each other. Belmont and Birch found that the group of retarded readers contained a significantly greater proportion of children who were deficient in left-right discrimination as measured by these tests. Within the group of retarded readers themselves, those who had difficulty in identifying their own body parts had the lowest reading scores. The results of this study did not concur with those found by Harris (1957) in testing nine-year-old children. Harris used only three items to test left-right discrimination, however, while seven items were used by Belmont and Birch. Benton and Kemble (1960) found a tendency for their nine-year-old subjects to have a poorer right-left orientation, but the difference was not statistically different. The difference in reading achievement between the two groups of Belmont and Birch may have been due to a difference in intelligence rather than to difference in left-right discrimination ability, but they found a

difference in left-right awareness of their own bodies within the retarded reader group itself.

Clark (1970) tested 1,544 children, 791 boys and 753 girls, from the primary grade school population of a county near Glasgow, Scotland. The children were all seven years of age and had completed two years of schooling. The children were tested on reading achievement and were given five instructions, as used in the Isle of Wight survey, to measure knowledge of left and right. Clark found that 15.3 percent of the total group was at the earliest stages of learning to read. With regards to left-right discrimination, Clark found that the children who made correct responses to all five questions had a slightly higher reading quotient; the level of significance was not given. She found that only 25 percent of the children could answer all five questions correctly and that 60 percent of them made a score of three or less. Clark concluded that left-right confusion at age seven should not be considered as clinically significant. The results might have been more conclusive had Clark indicated the level of significance of the difference between the mean reading quotients of discriminating subjects as compared with the mean reading quotients of the subjects who were rated as confused in left-right discrimination.

Hundleby (1969) found that children in grade three who did not show directional confusion scored significantly higher on reading ($p<.001$, $p<.02$) than children who did demonstrate directional confusion; ages not given. There was

no significant difference in word knowledge scores between the two groups. The eighty-six children in the sample were randomly selected from elementary schools in Victoria, B.C. The children were given the Lorge-Thorndike Intelligence Test and The Metropolitan Elementary Reading Test, word knowledge and reading subtests, by their classroom teachers. Hundleby administered the Benton Test of Right-Left Discrimination and the Informal Reading Inventory, graded oral and graded silent reading passages to each child in the sample. Hundleby concluded that the Benton Test of Right-Left Discrimination was an effective tool in identifying children with reading disability. Hundelby's study was well designed.

Smith (1970) in testing the relationship between right-left discrimination and reading achievement found a significant relationship ($p<.05$) between these two factors. Smith tested each child using the Neale Analysis of Reading Achievement to determine level of reading achievement and the Benton Test of Right-Left Discrimination to test the child's left-right discrimination. Smith also found a significant relationship between left-right awareness and (1) visual perception as measured by the Frostig Developmental Test of Visual Perception, Subtests I and IV ($p<.01$ and $p<.05$); (2) verbal ability as tested by the vocabulary subtest of the Wechsler Intelligence Scale for Children; (3) certain types of lateral dominance as measured by the Harris Tests of Lateral Dominance. Smith still found a significant relationship between left-right discrimination and reading

achievement when verbal ability was covaried out, but did not make a comparison of these two factors when intelligence was covaried out.

Benton and Kemble (1960) found no significant difference between the level of left-right discrimination ability of twenty children from a reading clinic and a control group of twenty children, who were rated by their teachers as average readers, from the normal school population. The two groups were matched for intelligence quotient and age. The reading clinic group had a mean age of nine years two months (S.D., 7.8 months) and a mean intelligence quotient of 103. The control group had a mean age of nine years three months (S.D., nine months) and a mean intelligence quotient of 103. The intelligence quotients were measured by the Stanford-Binet Intelligence Test or the Wechsler Intelligence Scale for Children, Verbal Scale. Benton and Kemble found that the children with reading disability tended to be poorer in all aspects of left-right discrimination, but the difference did not reach statistical significance ($p<.15$). This finding concurred with Harris (1957) who did not find a significant relationship between left-right discrimination and reading achievement in nine-year-old children. Benton and Kemble's results were different from those of Belmont and Birch (1965), who used a similar age group and found a significant relationship ($p<.01$). Benton and Kemble did not indicate what criterion was used to place the children in the reading disability group, nor did they report which reading tests the

teachers used to rate the children selected for the control group as 'normal'.

Silver and Hagin (1960) reported a controlled study comparing thirty reading disability children with a control group matched for age, sex, and intelligence quotient. The reading disability group was drawn from a population of 150 children from a mental hygiene clinic and a private medical practice. These children had originally been referred to the clinic for behavior problems. The method of selecting the sample was not given. The ages of the children in the sample ranged from eighty-one to 123. The proportion of boys and girls is not given. The control group matched for age, sex, and intelligence quotient was selected "from the same population". He may mean that the reading disability group and the control group came from the same school system.

The children were thoroughly studied neurologically and perceptually. They were given two reading tests, the <u>Gates Reading Diagnostic Test</u>, and the <u>Durrell-Sullivan Reading Capacity Test</u>. The tests of left-right discrimination were not described. Silver and Hagin found that 92 percent of the children with reading disability had defects in left-right discrimination ranging from inability to tell left from right in themselves and a disorientation in space. The control group had no such defect.

Balow (1963) tested 302 grade one children from a suburban school using the <u>Harris Tests of Lateral Dominance</u>; the <u>Gates Reading Readiness Tests</u>; the <u>Gates Primary Reading</u>

Tests, PWR-Word Recognition and PPR-Paragraph Reading; and the Lorge-Thorndike Intelligence Tests, Level One. Balow found no significant relation between knowledge of left and right and reading readiness, or between knowledge of left and right and reading achievement ($p > .05$). However, while knowledge of left and right and reading readiness were tested in September, reading achievement was not tested until the end of February. Therefore Balow could not say that there was no relation between knowledge of left and right and reading achievement at a given time. He could only have said that knowledge of right and left in September does not predict reading achievement in February. By February skilful teaching may have overcome any potential difficulties caused by lack of knowledge of left and right in September.

Coleman and Deutsch (1964) tested 114 public school children from a low socio-economic area, mostly Negro children, aged 9.5 to twelve years. They used the Harris Tests of Lateral Dominance, the Gates-McKillop Reading Diagnostic Tests: Oral Reading, the Gates Advanced Primary Reading Test, and the Benton Right-Left Discrimination Test. Coleman and Deutsch found no significant relation between level of left-right discrimination and reading achievement in this sample of children when intelligence was partialled out. Their sample of children was older than that of Smith (1970) and Belmont and Birch (1965) who found a significant relationship between left-right discrimination and reading achievement.

Studies regarding left-right discrimination and reading achievement were included in this review of research literature to obtain additional information on children who were low in reading achievement and had poorly developed left-right discrimination.

Summary. The majority of studies selected for this review reported a significant relationship between left-right discrimination and reading achievement.

Some additional information may thus be obtained about children who have these two characteristics concurrently:

1. Low reading achievement
2. Poorly developed left-right discrimination.

A summary of the studies reviewed above was made in Table 4.

THE RELATIONSHIP OF CEREBRAL DOMINANCE TO: LATERAL DOMINANCE, LEFT-RIGHT DISCRIMINATION AND READING ACHIEVEMENT

The Relationship of Cerebral Dominance and Lateral Dominance

In this review, cerebral dominance (Appendix E) means the cerebral hemisphere which controls the language functions; lateral dominance means the preferred side of the body for manual tasks. Various criteria have been used by different researchers to determine cerebral dominance and lateral dominance in the people whom they tested in their studies. Many theories regarding the relationship

Table 4

Summary of Studies on the Relationship Between Left-Right Discrimination and Reading Achievement

Researcher	Tests	Sample	Relationship to Reading	Criticism
Harris (1957)	Harris Tests of Lateral Dominance No reading test	316 reading disability cases from a reading clinic; IQ of 80 or over; median age, 10 years. 245 selected school children; second and fourth grade; IQ not given.	Age: 7 years, significant $p<.01$ Age: 9 years not significant	Used only 3 items to test left-right discrimination; controls may have had higher IQ's; no reading tests given.
Belmont and Birch (1965)	Similar to Benton Test of Right-Left Discrimination Three-hour battery of reading tests.	200 nine- and ten-year-old boys in Aberdeen, Scotland; 150 from lowest 10 percentile, retarded readers IQ 92.1; 50 not in lowest 10 percentile, controls IQ 104.	Significant $p<.01$	Found a significant difference in IQ between the two groups so could only compare within the retarded readers group.

Table 4 (continued)

Researcher	Tests	Sample	Relationship to Reading	Criticism
Clark (1970)	Five items to test left-right discrimination. Reading tests.	1,544 children; 794 boys and 753 girls; from the primary grade population of a county near Glasgow, Scotland; Age 7+.	Significant. If child had correct responses then he scored higher in reading.	Level of significance of the differences in reading quotients between confused and discriminating subjects not given.
Hundleby (1969)	<u>Benton Test of Right-Left Discrimination</u>; <u>Informal Reading Inventory</u>	86 children in grade three; elementary schools in Victoria B.C.; ages not given.	Significant; $p<.001$ $p<.02$	A well designed study.
Smith (1970)	<u>Benton Test of Right-Left Discrimination</u>; <u>Neale Analysis of Reading Ability</u> No IQ test	60 normal grade one children from a suburban school; mean age 6 years 11.68 months. IQ 80 or more.	Significant; $p<.05$	Well tested; both tests reliable. No IQ test given; might have been a difference due to intelligence.

Table 4 (continued)

Researcher	Tests	Sample	Relationship to Reading	Criticism
Benton and Kemble (1960)	Benton Test of Right-Left Discrimination Sections A, B, C. No reading tests.	20 children from a reading clinic; mean age 9 years 2 months; mean IQ 103. Control group: 20 average readers from a normal school population; mean IQ 104.	Not significant; $p<.15$	Did not measure the reading ability of the two groups on the same test; took teacher's word for reading achievement of the control group.
Silver and Hagin (1960)	Extensive neurological examination; tests of left-right discrimination not described; no reading test.	30 children with reading disability from a reading clinic; controls, 30 children from the same population matched for IQ, 81 to 123; sex and age, 8 years 6 months to 14 years.	92% of the reading disability group had defects in left-right discrimination; no such defects in the control group.	Difference between retarded readers and control group not clear; they seem to be from the same population, but this is unlikely; tests of left-right discrimination not described.

Table 4 (continued)

Researcher	Tests	Sample	Relationship to Reading	Criticism
Balow (1963)	Harris Tests of Lateral Dominance; Gates Primary Reading Tests; Lorge-Thorndike Intelligence Test	302 grade one children from a suburban school; mean IQ's of groups equal.	Not significant as a predictor of reading achievement.	Very limited number of items to test left-right awareness and reading achievement; were tested several months apart so they cannot be compared.
Coleman and Deutsch (1964)	Gates Advanced Primary Reading Tests; Harris Tests of Lateral Dominance; Benton Test of Right-Left Discrimination.	114 children from a low socio-economic urban area; mostly Negro; 9.5 to 12 years old.	Not significant, $X^2 = 6.17$, df=4, $p > .05$	Subjects older than those of Smith (1970), or Belmont and Birch (1965).

between these two factors have been proposed in the past more than one hundred years.

Hécaen and de Ajuriaguerra (1964, p. 1) consider that cerebral dominance, particularly where language development and pathology are concerned, cannot be studied independently of lateral dominance.

Broca, an anatomist and surgeon, in 1865 published a paper in which he presented a theory of dominance of one of the cerebral hemispheres in connection with speech behavior. Though it had been known for a number of years that each cerebral hemisphere controlled the motor movements on the opposite of the body, the idea of unilateral cerebral control of the language functions, both receptive and expressive, was new (Tomatis, 1969). Most of the research regarding cerebral dominance has been carried out in connection with language dysfunction (Hécaen and de Ajuriaguerra, 1964, p. 149).

Regarding the relationship of cerebral dominance to lateral dominance, the literature, in general, indicated that the left side of the brain was most often dominant for language functions regardless of whether the person was left- or right-handed (Bakes, 1966). Penfield and Roberts (1959) reported cases where aphasia in left-handed people followed injury to the right hemisphere. Aphasia was defined as any deficiency of: speech, understanding speech, reading, writing, or labelling. A very few cases, but some nevertheless, were reported where right-handed people developed

aphasia after injury or removal of the right hemisphere.

Penfield and Roberts (1959, p. 102) concluded, however, that the difference between the number of right-handed people and the number of left-handed people who developed aphasia after an operation on or injury to the right hemisphere was not significant. They took this as evidence that the left cerebral hemisphere generally controls speech, regardless of whether the person is left- or right-handed. They concluded further that cerebral dominance, or localization of the speech function, does not determine hand preference for motor tasks. Clark (1957) supported this conclusion.

Goodglass and Quadfasel (1954) reviewed 110 cases from the literature and thirteen new cases of lesions in either the right- or left-language area. Fifty-three percent of the left-handers were found to have language disturbances if the lesion were in the left hemisphere. Goodglass and Quadfasel concluded that cerebral dominance was not directly linked with lateral dominance, that is, preferred handedness in motor tasks.

Zangwill (1962) after reviewing the literature suggested that the cerebral organization of speech may be different in sinistrals than in dextrals. He noted that the recovery of language functions after damage to the left hemisphere was much quicker in sinistrals than in strong right-handed people. Zangwill theorized that language localization in the left hemisphere was weaker in left-handed

people than in dextrals, and that, therefore, the language function was more easily and more efficiently taken over by the right hemisphere after damage to the dominant hemisphere. Zangwill (1962, p. 109), unlike Goodglass and Quadfasel (1954) and Penfield and Roberts (1959), concluded that there was a real connection between hand preference and the organization of speech in the cerebral hemispheres in the cases they reviewed.

Hécaen and de Ajuriaguerra (1964, p. 148) also concluded that the cortical organization of the left-handed person was different from that of the right-handed person and that left-handed people had less hemispheric specialization and more ambilaterality than right-handed people, as well as recovering their language abilities more quickly after a left hemisphere injury than did right-handed people, a finding supported by Money (1966).

A test which purportedly gave some indication of a relationship between cerebral dominance and lateral dominance was described by Silver and Hagin (1960), based on Hoff and Schilder (1927). This test was used in the present study and also by Smith (1970).

Money (1966) described the Wada sodium amytal test for cerebral dominance. In this presurgical test, sodium amytal is injected into the carotid artery in the neck. Brief, transitory aphasia is induced if the injection is on the same side as the hemisphere which is dominant for language in that person; aphasia is not induced if the

injection is on the contralateral side. Bakes (1966) also described the sodium amytal test as reliable in determining cerebral dominance.

Crosby (1969, p. 108) reported that studies using the Wada test have only added to the confusion regarding dominance. The results of these studies have shown that there may be some interrelationship between lateral dominance and cerebral dominance. However, Crosby asserted, these tests have also shown that some other functions of the two cerebral hemispheres are not so related. Therefore he concluded that the evidence regarding the relationship between lateral dominance and cerebral dominance as provided by this test was not conclusive.

A possible relationship between lateral dominance and cerebral dominance was investigated in the present study through use of the Schilder arm extension test, the *Extensibility* test, as described by Smith (1970) and based on a description by Silver and Hagin (1960). The test was originally described by Hoff and Schilder (1927).

Summary. Cerebral dominance, whether left cerebral dominance or right cerebral dominance, was defined as a term which indicates which cerebral hemisphere controls the language functions; lateral dominance was defined as the preferred side of the body for manual tasks. This review of the literature regarding the relationship of cerebral dominance and lateral dominance indicated that, first, language function control, or cerebral dominance, was generally

located in the left cerebral hemisphere regardless of whether the individual was left- or right-handed.

It seems that lateral dominance and cerebral dominance are related, but the nature of this relationship is uncertain. Goodglass and Quadfasel (1954), Penfield and Roberts (1959), and Bakes (1966) concluded that these two factors are independent. Zangwill (1962) and Hécaen and de Ajuriaguerra (1964) on the other hand, claimed that the functional organization of the cerebral hemispheres is different in left-handed than in right-handed people and that therefore the two functions are related. The Wada test of cerebral dominance was described briefly.

A possible relationship between lateral dominance and cerebral dominance was investigated in the present study through use of the Schilder arm extension test, the Extensibility test, as described by Smith (1970) and based on a description by Silver and Hagin (1960). The test was originally described by Hoff and Schilder (1927).

The Relationship Between Cerebral Dominance and Left-Right Discrimination

In this review 'dominant hemisphere' (Appendix E) means the cerebral hemisphere which controls the language functions. Benton (1959, p. 132) described a child's level of body awareness as developmental in nature, a view shared by several other researchers, including Piaget (1928), Harris (1957), and Belmont and Birch (1963). Benton postulated that the development of left-right awareness depended

upon three factors: (1) an integration of somasthetic and visual sensory information; (2) learning, which is determined by experience and intelligence; and (3) the ability of the child to process language, which depends upon the status of his dominant hemisphere.

Impairment of any one of these three functions will result in the delay of the development of body awareness, Benton asserted. Of particular interest in this review was how injury to or disease of the dominant hemisphere affected this development of left-right awareness.

Benton discussed the concept of body schema, that is, a person's organized perceptual model of his body, as a determiner of that person's reactions to his own body. This concept of body schema, Benton noted, was first developed by Head. Injury to or disease of the dominant hemisphere, in particular, would disturb this schemata (Benton, 1959, p. 152; Kinsbourne and Warrington, 1966, p. 325). Benton discussed Head's formulation of the concept of body schema as compared with the earlier ideas of Pick.

Schilder (1931, p. 56) developed a complex explanation of body schema and of the symptoms which resulted when this schema was disordered by cerebral lesions. One of the manifestations of a disordered body schema, as noted by Schilder, was the phenomena of the phantom limb, in which the person 'feels' that a body part which has been surgically removed is still intact. Another symptom of this disordered body schema, as denoted by Schilder, was the

inability of a person to cross the midline of his body with one or the other hand. A third manifestation was the disorder known as Gerstmann's syndrome, or finger agnosia, as discussed by Kinsbourne and Warrington (1966). Schilder (1931, p. 62) described a persistance of posture test to determine if a person is normal with respect to his body schema.

Benton (1959, p. 141) noted that at about age five years children began to differentiate the left and right sides of their body. Some children could differentiate two sides of their body, but consistently responded opposite to verbal commands, that is, they showed a 'left' body part when asked to show a 'right' body part, and vice versa. Benton noted that the children who were consistently reversing had a lower level of language function than those who did not reverse. Furthermore, children who were consistently reversing on their own body were slower to correctly identify left and right on a person facing them.

Benton postulated the development of a 'right-left gradient' as the child further differentiated left from right at between the ages of five and six years. This gradient, he claimed, was essentially sensory-postural, and whether or not the child could correctly label left and right did not affect the gradient's development. However, before the child could progress to more complex left-right discrimination tasks, such as performing crossed commands on a picture of a person or on a person facing him, he must

have learned the verbal concepts of left and right, Benton stated.

One implication of the left-right gradient of the body schema is that is represents a higher level or organization of sensorimotor elements and not only a summation of these elements. Benton felt that further empirical evidence was needed before it would be known for certain if the left-right body schema theory explained the development of sensory modalities, such as hearing, feeling, and seeing, which require left-right discrimination.

The relationship between consistency of cerebral dominance as measured by the Extensibility test as described by Smith (1970) based upon Silver and Hagin's (1960) description of Hoff and Schilder's (1927) description of their arm extension test and the level of left-right discrimination ability as tested by the Benton Test of Right-Left Discrimination was examined in the present study to see what relationship existed between these factors in this sample of children. The relationship between level of left-right discrimination and verbal ability was also examined.

Summary. In this review of related literature 'dominant hemisphere' was defined as the cerebral hemisphere which controls the speech functions. Benton's theory of the development of a 'left-right gradient' of left-right body awareness was reported. Benton postulated a left-right gradient in the body schema which is developmental in nature. This left-right gradient is not dependent upon correct

application of the concepts of left and right, Benton stated, but he asserted further that these labels are necessary before the child can successfully discriminate left and right on a person facing him.

The development of these concepts, according to Benton's theory, is a facet of language function which is dependent upon the status of the dominant hemisphere. Therefore, left-right discrimination is related to cerebral dominance.

The relationship between consistency of cerebral dominance as measured by the Schilder extension test, the Extensibility, as used by Smith (1970) and based upon a description by Silver and Hagin (1960) and the level of left-right discrimination ability as tested by the Benton Test of Right-Left Discrimination was examined in the present study to see what relationship existed between these factors in this sample of children. The relationship between level of left-right discrimination and verbal ability was also examined.

The Relationship of Cerebral Dominance and Reading Achievement

Backwardness in reading may be due to a constellation of causes. One of the most common suggestions as to the origin of these deficits is lack of dominance of the major cerebral hemisphere over the minor one (Vernon, 1960). Orton (1937, p. 150) proposed a neurological explanation of a reading disability which he called 'strephosymbolia'. In

strephosymbolia, or twisted symbols, children have a tendency to reverse letters of the same form but which have an opposite orientation, for example 'b' and 'd', and 'p' and 'q', or when words or parts of words are read in reverse order, as in reading 'saw' for 'was' or 'tworrom' for 'tomorrow'.

Orton explained these reversals in terms of conflict between the non-dominant and the dominant cerebral hemispheres. He postulated that mirror-images were recorded in 'engrams' in the two cerebral hemispheres and that if unilateral cerebral dominance were not clearly established these mirror images would cause confusion in word recognition and recall (Orton, 1937, p. 153).

Orton's theory was, in general, supported by the findings of other neurologists, according to Bond and Tinker (1967). Bannatyne and Wichiarjote (1969) and Corballis and Beale (1971) also supported Orton's theory. However, it was not accepted by psychologists and people in the reading field who felt that there were other explanations of reversals in reading than interhemispheric conflict or lack of established dominance (Witty and Kopel, 1936; Johnstone, 1942; Goodglass and Quadfasel, 1954; Vernon, 1960; Eisenberg, 1966, and Bond and Tinker, 1967, p. 120). Clark (1957) also disagreed with Orton's theoretical assumptions, but saw that a delay in acquiring dominant laterality or attempts to change hand preference might cause directional confusion which in turn might result in a poor approach to

word reading and hence lead to reading difficulty.

In the present study the number of reversal errors which the children made in oral reading passages was noted. The relationships of these reversals to lateral dominance, consistency of cerebral dominance as tested in this study, and left-right discrimination were tested statistically. The children's visual perception for non-linguistic symbols was also tested.

Money (1966, p. 30) saw many problems in Orton's theory. Mirror imaging of language in the two hemispheres cannot be demonstrated empirically, Money stated; it can only be demonstrated that the motor functions of the right and left limbs are mirrored in the contralateral hemisphere. Furthermore, mixed dominance of the two hemispheres exists for motor functions, in cases of crossed laterality when a person may be left-handed and right-footed, for example, as well as for language functions. Money also asserted that tests of eyedness are completely unscientific since nerves and muscles from each eye connect with both sides of the brain.

Still further, mixed motor preference does not always exist in cases of reading disability as shown by the studies of Flescher, (1962), Hillerich (1964), Belmont and Birch (1965), Boos (1970) and Smith (1970). Obversely, children who have no reading disability may have mixed dominance.

Money (1966) concluded, therefore, that a simple

theory of cerebral hemispheric rivalry or one of mixed lateral dominance was not adequate to explain reading disability in relation to cerebral dominance. He asserted that it might be more profitable to regard the issue as a relationship between functions which are unilaterally represented, such as receptive and expressive language, and those functions which are bilaterally represented, such as seeing, hearing, touching, and motor movements, but which are related to the many aspects of language, including speaking, hearing, reading, writing, and spelling. There are many potential points where dysfunctions may develop. Hence it is not surprising that many cases of severe reading retardation cannot be explained in terms of certain relationships between any two of these functions, Money postulated.

Crosby (1969, p. 109) supported Money in this conclusion. He asserted that dominance is important in reading disability, even if it does not always exist in a certain relationship to reading disability. Crosby acknowledged that evidence regarding the relationship of lateral dominance and cerebral dominance to reading achievement was inconclusive. Crosby maintained, however, that educators should not dismiss various types of lateral dominance and cerebral dominance and various neurological disorders as being insignificant in relation to reading backwardness. The fact that atypical patterns of these factors was sometimes found in cases of severe reading retardation indicated to Crosby that they were significant in relation to reading

disability.

The present study investigated further the relationship among dominance characteristics and reading achievement.

Zangwill (1962, p. 109) suggested that it may be more fruitful to ascertain whether any particular type of reading backwardness exists in relation to certain anomalies of lateral dominance. This question might also be asked in connection with cerebral dominance.

Zangwill postulated three distinct syndromes to explain failure to establish normal cerebral dominance and normal lateral dominance with a concomitant reading disability. Firstly, he postulated, where anomalies of dominance and reading disability were concurrent, an actual lesion may be the cause. This lesion could lead to partial transference of handedness, and partial transference of the language functions, to the other hemisphere. This then would lead to incomplete lateral dominance and slowness in language development and thence to backwardness in reading. Evidence from electroencephalograms supported this statement, Zangwill reported. However, this explanation accounted for only a small proportion of severely retarded readers, so Zangwill proposed a second explanation.

Zangwill proposed, secondly, that some children who have, ill-defined lateralization or ill-defined cerebral dominance may also have a constitutional weakness in maturation; that is, they have had no brain damage as evidenced by electroencephalograms, but still mature slowly. A genetic factor

may be the cause of anomalies of dominance in these cases, he asserted.

Zangwill hypothesized thirdly that children who do not have strong lateral preferences may be more susceptible to stress. For example, children who do not have a strong tendency to lateral preference may be more likely to be affected more severely by minimal brain injury at birth and hence have retarded language development. Regardless of the causes of asymmetrical functions of the human brain, Zangwill concluded, a further exploration of the relationships among the above factors is necessary for a more complete understanding of reading and reading disorders.

The present study attempted to find a relationship between cerebral dominance and reading achievement. Reversal errors in oral reading were noted; relationships of these errors to lateral dominance and consistency of dominance, as measured by the Extensibility, were tested statistically.

Silver and Hagin in their 1960 study of 150 children from a mental hygiene population also examined the relationship between consistency of cerebral dominance and reading achievement in the clinic sample with these characteristics in a control group of normal readers from the same population. The children, aged eight years six months to fourteen years were originally referred to the clinic because of behavior problems. All of the children were given extensive neurological testing. To test for consistency of cerebral dominance Silver and Hagin (1960) used the Schilder

arm extension test (Hoff and Schilder, 1927). According to Silver and Hagin, the child is requested to close his eyes and raise his arms in front of him with fingers spread apart.

To be 'consistent' on this test, according to Silver and Hagin, the child should hold the hand with which he writes higher than the other. In their study Silver and Hagin found that 74 percent of the reading disability cases were inconsistent. None of the readers from the control group were inconsistent. Whitsell (1965, p. 51) cited the Silver and Hagin (1960) study and stated that Silver and Hagin found the Schilder arm extensibility test to be "practically diagnostic" of severe reading disability. It was not clear from Silver and Hagin's report of their study whether or not the children in the control group were from the mental hygiene clinic population. Silver and Hagin did not describe their tests of lateral dominance and did not report how reading achievement was measured in their study.

Smith (1970) in his study using a sample of sixty grade one children found no significant relationship between reading achievement and consistency of cerebral dominance ($p>.05$). Smith tested his children using the Extensibility test based on Silver and Hagin (1960), the Harris Tests of Lateral Dominance, and the Neale Analysis of Reading Ability.

This was a well designed study, but Smith's interpretation of Silver and Hagin's (1960) description of the test procedure was questioned. Hence, in the present study the

level of the children's hands was measured using a chart calibrated in centimeters.

Furthermore a copy of Hoff and Schilder's (1927) book was finally acquired and a translation of their test was obtained while data analysis was in progress to try to discern a more accurate description of the test procedure.

The children in Smith's study were from a normal school population, however, while those in Silver and Hagin's study were from a mental hygiene clinic having been primarily referred because of behavior problems. This may have accounted for the discrepancy in the results, and may have indicated the value of the Extensibility test in diagnosing severe reading disability coupled with emotional problems.

The present study used the Extensibility test on a sample of children in the second year of school to determine if the same relationship still existed between consistency and reading achievement. Comparisons were also made to see if the proportion of children who were consistent or inconsistent had changed significantly during the past year.

Summary. Orton's (1937) theory of interhemispheric conflict as a cause of reversals in reading was discussed. Articles which pointed out the shortcomings of this theory were cited.

Zangwill's (1962) theory to explain the failure of some children to establish normal cerebral dominance and normal lateral dominance with a concomitant reading

disability was presented. Zangwill postulated three distinct syndromes to explain this failure: (1) a lesion in the naturally dominant hemisphere; (2) a constitutional weakness in maturation; and (3) above normal susceptibility to stress. He also posulated a difference in cerebral organization between left- and right-handed people.

Two studies which examined the relationship between consistency of cerebral dominance and reading achievement were reviewed. Silver and Hagin (1960) found that 74 percent of their reading disability cases, drawn from a mental hygiene clinic population were inconsistent. Smith (1970) in his study of sixty grade one children from a normal school population found no relationship between consistency of cerebral dominance and reading achievement.

To try to discern a relationship between cerebral dominance and reading achievement in the present study the number of reversal errors which the children made in oral reading passages was noted. The relationship of these reversals to lateral dominance, consistency of cerebral dominance and reading achievement was tested statistically. The present study also investigated the relationship between consistency of cerebral dominance and reading achievement through using the Extensibility test.

A brief summary of these two studies was made in Table 5.

Table 5

Summary of Studies on the Relationship Between Consistent Cerebral Dominance and Reading Achievement

Researcher	Tests	Sample	Relationship to Reading	Criticism
Silver and Hagin (1960)	Schilder *Extensibility test*; Tests of lateral dominance not described. Reading test not given.	Group of 30 from reading clinic. Controls, matched 30 children from same population. 8-6 to 14 years.	Significant. 75% of retarded readers inconsistent.	No description of lateral dominance tests. Reading test not given. Clinic population.
Smith (1970)	Schilder *Extensibility test*; *Harris Tests of Lateral Dominance*; *Neale Analysis of Reading Ability*.	60 normal grade one children; mean age 6 years 11.68 months.	Not significant. $p>.05$	A well designed study.

CHAPTER III

DESIGN OF THE STUDY

The purpose of this chapter is to describe: the sample, the pilot study, the testing instruments, the method of collecting data, and the statistical analysis of the data.

DESCRIPTION OF THE SAMPLE

For this repeated measures study the sample consisted of fifty-seven children, thirty-one boys and twenty-six girls, in their second year of school. The children were those tested by Smith (1970).

The present researcher found fifty-seven of the sixty children who were in the original study and retested these children in May, 1971. Forty-nine of the children were still in the same three schools that had originally been made available to Smith by the Edmonton Public School Board. These schools were assigned by officials of the central school office with one each from a high, a middle, and a low socio-economic area. The sample represented a random selection of children from these designated schools, but not of all grade one children in the Edmonton Public School system. The remaining eight children were traced through school records.

Five of the eight had transferred to five different elementary schools in the City of Edmonton. Two were studying in an elementary school in Sherwood Park, a town about ten miles from Edmonton, while one child was in an elementary school in Calmar, a town about forty miles from Edmonton. The remaining three children had moved to schools more than 180 miles from Edmonton, so were not included in this repeated measures study.

Only fifty-one children were tested on the Gates-MacGinitie, Primary B, by the classroom teachers in June, 1971. Five children in the sample were repeating grade one, so received the Gates-MacGinitie, Primary A; one child was in a school where the Gates-MacGinitie was not given routinely, so these six children were excluded from the analysis of data on this test.

Smith's sample consisted of thirty-four boys and twenty-six girls. Children who were repeating grade one last year were excluded from Smith's (1970) sample, but all of the fifty-seven children found by the present researcher were retained in the 1971 study even though five of them were repeating grade one.

Table 6 gives a description of the sample and a comparison of the difference between the means of the Neale and WISC scores of girls and boys.

The children ranged in age from 7 years 4 months to 9 years 2 months, with a mean age of 7 years 10.08 months and a standard deviation of 4.84 months. Their ages were

Table 6

Description of the Pupil Sample

Pupil Sample	N	Age in Months		Lorge-Thorndike			Neale Reading			WISC		
		Range	Mean	Means	S.D.	Range	Means	S.D.	P*	Means	S.D.	P
Girls	26	7-4 to 9-2		105.3		86-128	32.08	14.63	0.50	27.54	6.01	0.98
Boys	31	7-4 to 9-2		105.3		82-129	29.74	11.25		27.48	6.80	
Total	57	7-4 to 9-2	7-10.08	105.33	12.32	82-129	30.81	12.83		27.50	6.40	

*Probability. A probability of beyond the .05 level was considered to be significant.

computed from their birth dates as shown in the school records.

The intelligence quotient scores of the children in the 1971 sample, as measured by the Lorge-Thorndike Intelligence Tests, Level Two, Form A, Primary Battery (the Lorge-Thorndike, Level Two), ranged from eighty-two to 129. The children had a mean intelligence quotient of 105.33 with a standard deviation of 12.32. The mean intelligence quotient of girls and boys was the same.

The children's intelligence quotient scores last year ranged from sixty-seven to 149, according to information on the school cumulative cards. The scores from the 1970 study were from different intelligence tests, that is, some were from the Detroit Beginning First Grade Intelligence Test and some were from the Lorge-Thorndike Intelligence Tests, Level One, Form A, Primary Battery. Therefore, the Lorge-Thorndike, Level Two, was administered this year so that the reading test means of groups of children who were confused, discriminating, and consistently reversing on the Benton A could be compared to see if there were significant differences between them when intelligence was covaried out.

The mean Neale score for the sample was 30.80 out of a possible 100 with a standard deviation of 12.83, placing 68.26 percent of the children (Helmstadter, 1970, p. 192) between a reading age of 7.4 years and 9.0 years. This indicated that the majority of the children in the sample

were reading above the mean chronological age of 7.10 years of the total sample. The difference between the girls' and boys' Neale mean scores was not significant.

The mean WISC score for the total sample was 27.50 out of a possible 80, with a standard deviation of 6.40. The mean score of 27.50 is equivalent to a scaled score of 12 which placed the children in the sample in the slightly above average range for this age group (Wechsler, 1949). The difference between the means of the girls and the boys was not significant.

An analysis of variance showed that there were no significant differences by sex on reading achievement or verbal ability in this sample. The size of the standard deviation showed that this sample met the underlying assumption of a normal distribution of the variables being measured in the parent population. An F-test on the differences between variances showed that this sample met a second underlying assumption of analysis of variance, that of homogeneity of variance (Ferguson, 1966, p. 294).

TESTING INSTRUMENTS

The tests described below, excepting the Gates-MacGinitie, Primary B, were administered to all of the children in the sample so that comparisons among reading achievement, lateral dominance, and left-right discrimination might be made. Tests of visual perception and verbal ability were also given so that the relationship of these two factors

to the preceding three factors might be determined. Samples of the unstandardized tests were placed in appendices and standardized tests were listed in the bibliography.

Tests of Reading Achievement

The Neale Analysis of Reading Ability (Form A, 1966) was used in this study as a measure of reading achievement mainly because it was a short, easily administered and standardized oral reading test. The test yielded a reading accuracy score, a speed score, and a comprehension score to determine the child's understanding of material which he reads orally; errors were classified according to type, including reversal errors. The child's attitude and approach to oral reading could also be recorded.

A total score combining comprehension, accuracy, and speed is normally used in this test, but in the present study only the accuracy score was used. The comprehension questions were asked to check if the child understood the material he read, but the comprehension scores were not included in the final scores. The speed score was also omitted because the present researcher was interested mainly in the accuracy with which children could read, rather than their speed. Of the various types of errors noted on the Neale, reversal errors had particular relevance for the present study and were used in the analysis of data.

The Neale (Neale, 1966) consisted of six passages of graded difficulty and increasing length, with controlled: vocabulary, sentence structure and sentence length. The

test was untimed. Reliabilities for word accuracy scores on alternate forms are .96 or more.

Neale (1969) reported that the use of parallel forms of the same test is a common way to test the reliability of educational tests. Neale (1969) reported reliability correlations of .96, .97, and .98 which he stated were comparable to that of the Vernon Word Reading Test and the Revised Stanford-Binet Intelligence Test.

Norms for the Neale were standardized in Great Britain using a sample of five hundred children selected by random numbers. Validity, as assessed by comparing the Neale scores with the Schonell English Usage Test and Ballard One-Minute Test, was .95 (Neale, 1969). This test was not reviewed in Buros (1965), the latest edition of the Mental Measurements Yearbook.

The Gates-MacGinitie Reading Tests, Primary B, Form I, Vocabulary and Comprehension (1964) scores were used to assess the level of silent reading achievement of the children in the sample.

The Vocabulary Test measured the child's knowledge of word meanings. It consisted of forty-eight exercises of increasing difficulty with each exercise containing a picture and four words and required the child to circle the word that best corresponded to the picture (Gates and MacGinitie, 1965).

The Comprehension Test assessed the child's ability to understand sentences and paragraphs. It consisted of thirty-four passages of increasing length and difficulty,

each passage having a panel of pictures with it. The child was required to mark the picture which best showed the meaning of the passage, or that answered the question asked in the passage.

The Gates-MacGinitie, Primary B replaced the Gates Primary and Advanced Primary Reading Tests and the Gates Reading Survey, but was not reviewed in Buros (1965).

Gates and MacGinitie (1965) reported a split-half reliability coefficient of .93 for the Gates-MacGinitie Reading Tests, on a norming population of forty thousand children representing thirty-eight communities in the United States. They reported a correlation of .78 between Gates-MacGinitie, Primary B, comprehension subtest scores on a retest subsample of one thousand children.

Tests of Lateral Dominance (Appendices A and B)

The Harris Tests of Lateral Dominance were administered to determine handedness, eyedness and footedness of each pupil so that lateral dominance status could be determined (Harris, 1958). The standardized test included: (1) ten tasks to assess hand preference; (2) a test in which simultaneous writing with both hands was involved; (3) tests of speed and coordination in hand-writing, tapping and dealing cards; (4) two tests of foot preference; (5) three tests of eye dominance; (6) a simple three-item test of knowledge of left and right.

The Harris was reviewed by Peacher and Tinker in Buros (1953) and was described as interesting and simple to

administer. The *Harris* is a standardized test but Tinker suggested that more data on the reliability of the tests was needed. Harris did not give data on the validity of the subtests, so Tinker assumed that Harris claimed face validity for the tests.

In the present study the ten tests of hand preference were used. Two tasks from the *Harris* were given to determine the eyedness of the pupils; the eye used for each task was noted. Kicking and stamping were the tasks used to determine footedness. Each subject was classified as being:

1. Left-
2. Right-
3. Incomplete-
    a. Handed
    b. Eyed
    c. Footed.

Each pupil was also given a total dominance rating of established lateral dominance or crossed dominance.

The *Extensibility* (Appendix B) test was administered to each pupil. This was a test used by Smith (1970) to try to determine if dominance as measured by the *Extensibility* were consistent or inconsistent with lateral dominance as measured by the *Harris*. Smith based his description of the test upon that of Silver and Hagin (1960) who extrapolated from Hoff and Schilder (1927) who wrote in German. No English translation of Hoff and Schilder's description of

their test was available at the beginning of the experiment but a translation was secured during the analysis of data; further analyses were carried out on the basis of this added information.

The child was asked to close his eyes and raise his arms in front of him with his fingers outstretched. The height of his hands was measured using a chart calibrated in centimetres as described in the pilot study.

The child was classified as consistent if he held the same hand higher as was his hand used in writing as measured by the Harris. He was classed as inconsistent if he did not hold his writing hand higher on the Extensibility. In this test a hand was considered to be held higher even if there were only a barely-noticeable difference of one centimeter or less.

This test does not have established reliability.

Tests of Left-Right Discrimination

The Benton Test of Right-Left Discrimination (Appendix C) was used to measure the children's left-right discrimination ability. The child was required to perform certain movements in response to oral commands. The test consisted of thirty-two commands which were categorized into three sections:

1. The Benton A which consisted of twenty-four commands requiring the child to point to his own lateral body parts (twelve with eyes open and twelve with eyes closed).

2. and 3. The Benton B and C each of which contained

four commands requiring the child to perform crossed lateral movements involving both his own lateral parts and those of the drawing of a man facing him, for example, "Put your left hand on the man's right shoulder."

The test battery subtests, A, B, and C, were scored separately; a total score was given as well, but was not used in classifying the children. Using the method described by Smith (1970) the subjects were classified thus:

1. On the Benton A pupils having scores of:
    a. Two to twenty-one were classed as confused on A
    b. Twenty-two, twenty-three, or twenty-four were classed as discriminating
    c. Zero or one were classed as consistently reversing
2. On the Benton B, pupils making:
    a. Any errors were classed as confused
    b. No errors were classed as discriminating.
3. On the Benton C, pupils making:
    a. Any errors were classed as confused
    b. No errors were classed as discriminating.
4. The total score on the Benton was the sum of the correct scores on subtests A, B, and C.

Benton and Menefee (1955) reported a split-half reliability coefficient of .88 using the Spearman-Bowman formula on an earlier form, date not given, of the Benton-Test of Right-Left Discrimination. Coefficients of

equivalence for the earlier form were found to be .72 and .67. The earlier form is analogous to subtests A and B of the Benton as used in the present study. The Benton was not reviewed in (Buros, 1953, 1959, or 1965).

The Non-Verbal Test of Directional Orientation (Appendix D) was an experimental test devised by Smith (1970) as an additional measure of left-right awareness. One criticism of the Benton has been that understanding of the verbal labels 'left' and 'right' is necessary in order to follow the oral commands on the test. The possibility exists that a child could have directional orientation but do poorly on the Benton because he did not have the appropriate language labels. Thus, Smith (1970) constructed a test which attempted to measure left-right discrimination without using the verbal labels of 'left' and 'right' in the commands. The test had three parts. A fourth part, the Non-Verbal D, was constructed and added by the present researcher. The four parts were:

1. The Non-Verbal A required the child to respond to ten commands regarding pictures on ten cards. Each card had certain objects on either side of its midline. The child was asked to raise his hand which was on the same side of the picture as a specified object. One command, for instance, was "Raise your hand which is on the same side of the line as the cow."

2. The Non-Verbal B required the pupil to touch the body parts of a picture of a youth which was lying on a table top. The pupil sat opposite the examiner and both had

had an identical picture of a youth facing them. The examiner pointed to the various body parts of her picture and instructed the child to do likewise, saying, for instance, "Use the same hand as I am using and touch this shoulder of the man." There were eight commands in this task.

3. The Non-Verbal C required the pupil to reproduce twelve nonsense words on a metal tray. The nonsense words were: puq, bap, peb, qub, bordis, daput, debum, qudos, qupez, breqof, drugas, padorz.

The examiner used two metal cookie sheets, size eleven by sixteen inches, and Instructo (1969) magnetic lower case letters. The letters were scattered randomly on one tray thus:

a. Three of each letter used singly in any of the words

b. One of each of the other letters of the alphabet not used in any of the test words. The second tray was used for the construction of the nonsense words.

The examiner constructed the nonsense word on the metal tray, giving these verbal instructions first: "Watch me carefully and when I have finished make this word exactly as I have done." The nonsense word was left on the tray while the child copied it. The child was observed while he chose the letters and laid out the word, but the test was untimed. If the child's word matched that of the examiner he was credited with having it right, regardless of how long it took him or whether or not he laid the letters down in correct order. The letters had to be oriented correctly.

4. The _Non-Verbal D_ (Appendix D) required the pupil to touch various body parts in an outline drawing of a woman and to touch certain objects as related in the report of the pilot study.

In each subtest the child was given one point for each correct response with subtest scores being recorded separately. Two _Non-Verbal_ totals were calculated. _Non-Verbal_ total one (Appendix E) was the total of scores on subtests A, B, and C. _Non-Verbal_ total two (Appendix E) was the total of scores on Subtests A, B, C and D. A child was classed as confused on the _Non-Verbal_ total one if he scored below the median of twenty-six. If he scored twenty-six or more on the _Non-Verbal_ total one he was classed as discriminating. A child was classified as confused on the _Non-Verbal_ total two if he scored below the median of thirty-four. If he scored thirty-four or more, he was classified as discriminating on the _Non-Verbal_ total two.

Subtest D was added to the _Non-Verbal_ test in an attempt to provide a test which: (1) did not use the verbal labels left and right, and (2) was more difficult than subtests A and C, but less difficult than subtest B. Subtest A required only that the child be able to match his movements to one side or the other of a picture, that is, it tested only the ability of the child to differentiate one side of his body from the other. Subtest C was also a straight matching task, requiring the child to copy a nonsense word by choosing the correct letters and making a similar word.

It combined the testing of visual perception with the testing of left-right discrimination. The words were made up of letters which Eisenberg (1966) and Money (1966) cite as causing the most problems for children who have difficulty learning to read. When the child had chosen the correct letters he was required to lay them out in the same order as the sample word. The time required to complete each word did not affect the score.

The Non-Verbal B presented much more difficult tasks for the children in that they were required to re-orient their own bodies in space in order to perform the double transposition commands. This ability is the latest to be acquired by the child (Piaget, 1927).

The Non-Verbal D required the child to think 'outside of himself' but he did not have to re-orient himself in space. Thus subtest D was added as a task more difficult than subtests A and C, but less difficult than subtest B.

The Non-Verbal D was an experimental subtest made up for this study, so does not have established reliability nor established validity. Similarly, the Non-Verbal subtests A, B, and C which were originated by Smith (1970) did not have established reliability nor validity.

Test of Visual Perception

The Marianne Frostig Developmental Test of Visual Perception was chosen to measure visual perception since visual perception is a component both of left-right discrimination and of reading achievement. This standardized test

consists of five subtests, each of which measures a different aspect of visual perception. They are described in the Frostig manual (Frostig, *et al.*, 1966).

The five subtests are:

1. Eye Motor Coordination, which requires the child to draw continuous, straight, curved or angled lines between boundaries of various width, or from point to point without guidelines.

2. Figure-Ground, which involves shifts in perception of figures against increasingly complex backgrounds. Intersecting and hidden geometric figures are used. The child must outline specified figures.

3. Constancy of Shape, which requires the child to recognize certain specified geometric figures presented in a variety of sizes, shadings, textures, and positions in space, and their discrimination from similar geometric figures.

4. Position in Space, which requires the child to discriminate reversals and rotations of figures presented in series.

5. Spatial Relations, which requires the child to analyze simple forms and patterns consisting of lines and angles and then copy these forms, using dots as guidelines.

The test was used in the present study to discern if visual—perceptual ability were correlated with reading achievement and left-right discrimination in children in the second year of school.

The *Frostig* was reviewed in Buros (1965, p. 553) by Anderson and Austin. Neither of these reviewers were wholly favorable in their comments about the *Frostig*. However, they both saw this test as a useful tool in educational and psychological diagnosis.

Austin reported a test-retest reliability coefficient of .80 for the perceptual quotient, which she stated was not clearly defined by Frostig *et al*. Austin reported an average reliability coefficient for the subtests of .62 ranging from .42 for the figure-ground subtest (subtest II) to .80 for the form constancy subtest (subtest III). Validity was investigated through correlations between teacher ratings of pupil adjustment and scaled scores on the *Frostig* (Buros, 1965, p. 554). Frostig *et al*.(1961) described their standardization sample of 434 children in kindergarten and grades one and two.

Test of Verbal Ability

The *Wechsler Intelligence Scale for Children*, vocabulary subtest, was included in the study to measure verbal ability. It is not intended as a comprehensive test of language, but as a simple, quick and accurate estimate of the child's knowledge of words. The vocabulary subtest consists of eighty words of increasing difficulty which the child is asked to define. The reliability of this subtest is .77 (Wechsler, 1949, p. 13). Its validity as a measure of verbal status was shown by Maxwell (1959) in his factor analysis study which demonstrated that the vocabulary subtest

is loaded highly, .319 ($p<.05$), on a verbal factor; this subtest also correlates quite highly, .66, with the total verbal score (Wechsler, 1949, p. 10).

Test of Intellectual Ability

The Lorge-Thorndike Intelligence Test, Level Two, was administered to all of the children in the sample so that the reading achievement of children who were classed as confused, discriminating or consistently reversing on the Benton A could be compared when intelligence was covaried out.

The Lorge-Thorndike, Level Two, is a group test consisting of pictorial materials and oral instructions and having three subtests.

Lorge and Thorndike (1962) reported a split-half reliability of .761 for the Lorge-Thorndike, Level Two. They also reported correlations of moderate size between the Lorge-Thorndike, Level Two, and subtests and total of the California Achievement Tests: reading .63, arithmetic .59, language .56, spelling .47, total achievement .65.

The Lorge-Thorndike, Level Two, was an untimed test with each subtest requiring eight to ten minutes to administer. Each key word was spoken twice and instructions were repeated if a child were having difficulty with a response. A rest period of five minutes was allowed between the subtests, which were given consecutively, as recommended in the examiner's manual (Lorge and Thorndike, 1957).

THE PILOT STUDY

The pilot study, carried out on April 15, 1971, had three purposes:

1. To test whether a child could follow directions regarding left- and right-hand movements when the examiner sat beside the child and gave instructions regarding an outline picture of a woman facing the child, as required in a new subtest, D, of the Non-Verbal (Appendix D).

2. To check out the administration procedure to be used in giving subtest D which was added to the Non-Verbal by the present researcher.

3. To determine if a chart calibrated in centimeters did aid in measuring the height at which the children held their hands on the Extensibility.

The Sample

Four children, two boys and two girls, were selected at random from a neighborhood near the University of Alberta campus. The children ranged in age from six years old and in grade one to eight years old and in grade three. One child was eight years old and in grade two.

Data Collection

The Non-Verbal D required the pupil to touch the body parts of a woman in an outline drawing and to touch certain objects. The pupil sat beside the examiner at a table. In the first part of the subtest the pupil and the examiner each had an outline drawing of a woman facing them. The examiner

pointed to various body parts of her picture of the woman and instructed the child to do likewise, saying, for instance, "Use the same hand as I am using and touch this hand of the woman." There were eight commands in this part of the test. The set of commands was prefaced by the remark, "I want you to listen carefully and then do exactly as I say." The child was reminded to keep his hands on his lap until the examiner had removed her hand.

In the second part of the Non-Verbal D, two commands were given. The pupil and the examiner still sat side by side. In this part of the Non-Verbal D, three objects: (1) a bottle opener, (2) a pencil, and (3) a spool, were set in a row in front of the pupil. Identical objects were set in the same order in a row in front of the examiner. The examiner pointed to one of the objects in front of her and said, "Use the same hand as I am using and thouch this object." The child was required to copy the examiner's movements regarding the objects in front of him, again keeping his hand on his lap until the examiner removed hers from the picture. The child was given one point for each correct response.

Results (Table 7)

On the Non-Verbal D:

1. One child, aged eight years and in grade three, performed all ten tasks correctly

2. One child who was youngest had the fewest items correct

Table 7

Number of Correct Responses of Pupils in Pilot Study on Non-Verbal "D" Test

Subject	Questions 1	2	3	4	5	6	7	8	9	10	Total	Hand Used in Writing	Hand Held Highest in Extensibility
1	1	1	0	0	1	0	0	1	1	0	5	R	L
2	1	1	1	1	1	1	1	1	1	1	10	R	L
3	1	1	0	0	1	0	1	1	1	0	6	R	L
4	0	1	1	1	1	0	0	1	1	0	6	R	R

3. The child who was eight years old and in grade two had the same number correct as the child who was seven years old and in grade two.

Regarding the Extensibility:

When the children held their hands one centimeter or less apart it was very difficult to ascertain which was actually the higher.

COLLECTION OF DATA

Testing for the main study was carried out in the last two weeks of April and the first week in May, 1971. The present researcher administered and marked the six individual tests and the two group tests in the main study. The individual tests were given individually and in random order to all fifty-seven of the children in the sample as determined by a table of random numbers (Keeping and Kenney, 1954). A rapport-gaining set of questions (Appendix F) was given at the beginning of each individual testing session to put the child at ease. The individual tests required a total of about forty-five minutes per child.

The two group tests, the *Frostig* and the *Lorge-Thorndike*, Level Two, were given in groups of nineteen or less. These tests required about forty-five minutes for each group. A ten minute rest period was given after subtest two of the *Frostig*; a five minute rest period was given after each subtest in the *Lorge-Thorndike*, Level Two, as suggested in the manuals (Frostig, *et al.*, 1966; Lorge

and Thorndike, 1957). When these group tests were administered individually, as was necessary in eight cases, the Frostig required about twenty-five minutes and the Lorge-Thorndike, Level Two, about forty-five minutes. The Lorge-Thorndike, Level Two, was always given last in the April-May testing session.

The children in the sample were also tested in random order as determined by a table of random numbers (Keeping and Kenney, 1954). This order was modified in two schools where the children were in more than one room; the children were taken in their assigned random order one room at a time. To make comparisons between the 1971 and 1970 tests results possible, however, the children were assigned the same identification numbers as used by Smith (1970).

An eighth test, the Gates-MacGinitie, Primary B, Form I, was administered to fifty-one of the children in the sample by the classroom teachers in June, 1971. Then the scores were made available to the present researcher. A statistical analysis of this additional data was carried out, and the results were incorporated into those of the main study. The Gates-MacGinitie, Primary B, scores of only fifty-one children were used in the analysis of data because one child in the April-May sample was not given the Gates-MacGinitie, Primary B, test in June, 1971, and five of the children who were in the April-May sample were repeating grade one so were given the Gates-MacGinitie, Primary A, Form One. The scores from the Gates-MacGinitie, Primary A,

could not be compared statistically with the scores from the Gates-MacGinitie, Primary B, so the Gates-MacGinitie scores of these five children were excluded from the analysis of data.

STATISTICAL ANALYSIS OF DATA

The data were analyzed using computer programs set up by the Division of Educational Research Services of the University of Alberta using: intercorrelations, t-tests, one-way analyses of variance, one-way analyses of covariance, chi-square tests, z-tests, correlated t-tests, and three-way multivariate analysis of variance and covariance. The .05 level of significance or beyond was accepted in this study. The instances in which these various statistics were used were listed below.

Correlations

1. Pearson product-moment correlations between the following variables, and the probability for each correlation, were computed:

   a. Age

   b. *Neale* scores

   c. *Gates-MacGinitie*, vocabulary and comprehension scores

   d. *Benton*, subtest and total scores

   e. *Non-Verbal*, subtest and total scores

   f. *Frostig* subtest and total scores

   g. *WISC* vocabulary subtest scores

h. Lorge-Thorndike scores.

T-tests

Whenever comparison of two independent groups was required, a t-test was used to test the significance of the difference between the two means. An F-test for homogeneity of variance was carried out on each variable. The results of these tests show that the assumption of equal variance in the population from which the sample was taken was met in all but thirteen out of ninety-six cases for the t-tests (Appendix H).

The significance of the difference between the mean scores of the following groups was tested:

1. The scores of the Neale, the Gates-MacGinitie vocabulary and comprehension, the Frostig subtests and total and the WISC vocabulary subtest of the following pairs of groups were compared:

a. Confused and discriminating pupils on the:

(1) Benton B

(2) Benton C

(3) Non-Verbal total one

(4) Non-Verbal total two

b. Mirror reversers (Appendix E) on the:

(1) Benton total

(2) Non-Verbal total two

c. Crossed and established dominant pupils

d. Consistent and inconsistent pupils on the Extensibility test

e. Pupils who made reversal errors on the Neale and those who did not

f. Boys and girls.

2. The Benton subtest and total scores and the Non-Verbal subtest and total scores of the following pairs of groups were compared:

Groups c., d., e., and f. in 1. above.

One-Way Analysis of Variance

Whenever comparison of three independent groups was required, a one-way analysis of variance was carried out to test the significance of the differences between the means. If F's were significant a Newman-Keuls test was performed on the means to determine between which means the differences were. A chi-square test for homogeneity of variance was carried out on each of the variables analyzed by analysis of variance (Appendix H). The assumption of equal variance in the population from which the sample was taken was met in most cases; the few cases where this assumption was not met are shown in Appendix H. The significance of the differences between the following groups were computed:

1. With the scores of the Neale, the Gates-MacGinitie (vocabulary and comprehension), the Frostig subtests and total, and the WISC vocabulary subtest as the dependent variables the following groups were compared:

a. Benton A status, as the independent variable:

(1) Confused

(2) Discriminating

(3) Consistently reversing

b. Harris status as the independent variable:

(1) Handedness, Eyedness, Footedness:

(a) Left

(b) Right

(c) Incomplete

(2) Dominance:

(a) Established

(b) Dominance one (crossed hand and foot or crossed foot and eye)

(c) Dominance two (crossed hand and eye)

c. Extensibility Two status:(Appendices E and G):

(1) Consistent

(2) Inconsistent

(3) Incomplete

2. With the scores of: (1) the Benton subtests and total, and (2) the Non-Verbal subtests and totals one and two as the dependent variables, and status on the following tests as the independent variable, the following groups were compared:

a. Harris status as in 1.b. above

b. Extensibility Two status as in 1.c. above.

One-Way Analysis of Covariance

Six one-way analyses of covariance were carried out to determine whether status on the Benton A affected reading achievement when verbal ability and intelligence were

covaried out using as:

1. Independent Variable:

   Status on the Benton A:

   a. Confused

   b. Discriminating

   c. Consistently reversing

2. Criterion Variables:

   a. Neale score

   b. Gates-MacGinitie, Comprehension scores

3. Covariates:

   a. WISC vocabulary subtest score

   b. Lorge-Thorndike score

Chi-Square Tests

Chi-square frequency tests were carried out to test the relationship between the following:

1. Lateral dominance as measured by the Harris and the Extensibility and:

   a. Reversals in oral reading as measured by the Neale

   b. Left-right discrimination as shown by pupil scores on:

      (1) Benton A

      (2) Benton B

      (3) Benton C

      (4) Benton total

      (5) Non-Verbal total one

      (6) Non-Verbal total two

(c) Consistent dominance, inconsistent dominance or incomplete dominance on the Extensibility Two.

2. Mirror reversals on the Benton total and:

   Mirror reversals on the Non-Verbal total two.

Z-Tests

To test hypothesis nine it was necessary to test the significance of the difference between the proportion of children who were classified in a certain way in 1971 and the proportion who were similarly classified in 1970. Z-tests were used, with a Z value of more than 2.58 required for significance at the 1 percent level; and a Z value of 1.96 or more required for significance at the 5 percent level. The 5 percent level was accepted in this study. Levels of significance beyond 5 percent were noted, however.

The children were compared on:

1. Lateral dominance:
   a. Left, right, incomplete:
      (1) Handedness
      (2) Eyedness
      (3) Footedness
   b. Established and crossed dominance
   c. Consistent and inconsistent extensibility
2. Left-right discrimination:
   a. Confused, discriminating and consistently reversing on the Benton A

b. Confused and discriminating on the

(1) Benton B

(2) Benton C

(3) Non-Verbal total one

Correlated T-Tests

To test hypothesis ten, a test of the significance of the difference between the means for correlated samples was required. The data were composed of pairs of measurements, which were the children's scores on certain tests in 1971 and the scores of the same children on the same tests in 1970. To compute the correlation coefficient between paired observations the difference method was employed (Ferguson, 1966, p. 169).

The significance of the difference between the two means for correlated samples in the present study was computed. Mean scores on the following tests were compared, the:

1. Neale
2. WISC
3. Benton, subtests and total
4. Non-Verbal, subtests and total
5. Frostig, subtests and total

Three-Way Multivariate Analysis of Variance and Covariance

When the one-way analysis of covariance showed a significant or near significant (.06, .07, .08) difference existed between the means of three groups,

as between the *Neale* scores of confused, discriminating and consistently reversing subjects, a three-way multivariate analysis of variance and covariance was carried out to discover between which means the difference lay, using ANOV35.

Assumptions

The underlying assumptions of the above analyses as described by Keeping (1962, p. 251), Winer (1962, p. 586) and Ferguson (1966) were noted.

SUMMARY

This chapter described the sample, the testing instruments, the pilot study, the method of collecting data and the statistical analysis of the data. Fifty-seven children were tested individually on the:

1. *Neale Analysis of Reading Ability*
2. *Harris Tests of Lateral Dominance*
3. *Extensibility Test*
4. *Benton Test of Right-Left Discrimination*
5. *Non-Verbal Test of Directional Orientation*
6. *Wechsler Intelligence Scale for Children*, vocabulary subtest

and in groups on the:

7. *Marianne Frostig Developmental Test of Visual Perception*
8. *Lorge-Thorndike Intelligence Tests*, Level Two.

The following statistical analyses were carried out on the data:

1. Pearson product-moment correlations
2. T-tests on independent groups
3. One-way analyses of variance
4. One-way analyses of covariance
5. Chi-square tests
6. Z-tests
7. T-tests on correlated samples
8. Three-way multivariate analysis of variance and covariance.

The scores of fifty-one children on the Gates-MacGinitie Reading Test, Primary B, Form 1, which was administered by the classroom teachers in June were made available to the present researcher. These children formed a subsample and the additional data were also analyzed using the above analyses.

CHAPTER IV

FINDINGS OF THE STUDY: PUPIL PERFORMANCE ON VARIOUS TESTS

This chapter presents the findings of the study and a discussion of these findings under the following headings:

1. Pupil performance on tests of:

    a. Left-right discrimination

    b. Lateral dominance

    c. Reading achievement

    d. Verbal ability

    e. Visual perception.

2. Differences between pupil performance on various tests in 1971 and 1970, using the following statistical analyses:

    a. Correlated t-tests

    b. Z-tests for correlated proportions.

In general, the organization of chapters four, five and six and their tables followed the sequence of Smith (1970) so that comparisons of the reported findings could be made. Additional data, gathered in the present study is given where appropriate. To aid the reader in interpreting the findings of this study an attempt was made to follow a uniform format throughout chapters four, five and six. Comparisons and summaries of the 1971 and 1970 findings, when suitable, are

presented at the end of each section in the three findings chapters.

In reporting the results of statistical analyses a level of significance at the .05 level was accepted, as it was considered to be sufficiently rigorous for the present study; relationships which reached this level were accepted for the hypotheses concerned, while relationships at the .06, .07, .08, and .09 levels were considered to be approaching significance. Relationships which were beyond the .01 and .001 levels of significance were noted.

The assumption of a normal distribution of the variable being tested which underlies:

1. T-tests
2. One-way analysis of variance
3. One-way analysis of covariance
4. Correlated t-tests

was not met in some cases in this study since the majority of the children scored very high on certain tests, resulting in some strongly negatively skewed distributions. On one test there was a strongly positively skewed distribution. The above statistical analyses are fairly "robust" with regard to the assumption of a normal distribution of scores, but some caution must be used in interpreting the results of statistical analyses involving tests where this assumption was not met.

Similarly for the above analyses, a test for homogeneity of variance was carried out for each variable in each

group. The results of these tests, which show that the assumption was met in all but 24 out of a total of 168 cases, are given in Appendix H.

PUPIL PERFORMANCE ON TESTS OF LEFT-RIGHT DISCRIMINATION

In this section the performance of pupils on two tests of left-right discrimination, the:

1. Benton Tests of Right-Left Discrimination
2. Non-Verbal Test of Directional Orientation

is reported.

In addition, the 1971 pupil performance on these tests is compared with the 1970 pupil performance as reported by Smith.

The Benton Test of Right-Left Discrimination

The majority of the children scored very high on the Benton A, mean score 18.96 out of 24, standard deviation 8.05 (Table 8).

Table 8

Means and Standard Deviations of Pupil Scores on the Benton

Total Pupil Sample: Calculations	Performance on: Benton A	Benton B	Benton C	Benton Total
Means	18.96	1.86	1.11	21.86
Standard Deviations	8.05	1.91	1.41	8.94
Possible Scores	24	4	4	32

Of the children in the present sample who could differentiate between the two sides of their body, about 70 percent knew the language labels for left and right while about 10 percent did not possess these verbal labels (Table 9). About 19 percent of the pupils could not consistently discriminate between the two sides of their bodies, so were classed as confused.

Table 9

Percentage of Confused, Discriminating, and Consistently Reversing Pupils on the Benton

Sample Sub-Groups	Representation of Sub-Groups on: Benton A N	%	Benton B N	%	Benton C N	%
Confused	11	19.3	33	57.9	53	92.9
Discriminating	40	70.2	24	42.1	4	7.1
Consistently Reversing	6	10.5				
Total	57	100.0	57	100.0	57	100.0

On the Benton B, the majority of children scored very high. Children were classified as confused or discriminating on the Benton B, with the figure of 58 percent confused indicating that the pupils found the tasks on the Benton B more difficult than those on the Benton A.

The Benton C was the most difficult of the three Benton subtests with most of the children scoring very low (mean 1.11 out of 4).

Benton (1962) reported that 87 percent of the seven-

year-old children in his sample could discriminate left and right on their own bodies, while the present study found a comparable 81 percent. Several other researchers (Piaget, 1928; Benton and Menefee, 1957; Benton, 1959; Belmont and Birch, 1963; Clark, 1970; and Smith, 1970) have also reported on the left-right discrimination ability of young children; their general findings indicated that children's left-right discrimination ability increased with age. The beginning of such a trend in the present sample of pupils is evident from the results of this study.

The Non-Verbal Test of Directional Orientation

The scores on the Non-Verbal A, C, and D and on the Non-Verbal total one (Appendix E) and total two showed that most of the children scored very high on these subtests and totals.

Almost all of the pupils could raise their left and right hand to correspond to the same side of a card in which the picture of a certain object had been placed (Table 10). This indicated that they found the tasks on the Non-Verbal A very simple.

On the Non-Verbal B the pupils made a mean score of 3.72 out of 8 with a standard deviation of 2.60 (Table 10), which meant that they found the tasks on this subtest difficult, in that the pupil was required to make a double transposition of his body in space, having to copy the movement of the examiner, who sat across a table from him.

Table 10

Means and Standard Deviations of Pupil Scores on the Non-Verbal Subtests and Totals One and Two

Total Pupil Sample (N=57) Calculations	Pupil Performance on: Non-Verbal A	Non-Verbal B	Non-Verbal C	Total One	Non-Verbal D	Total Two
Means	9.95	3.72	11.74	25.47	8.51	33.98
Standard Deviations	.29	2.60	1.01	3.00	1.86	3.76
Possible Scores	10	8	12	30	10	40

The Non-Verbal B is analogous to the Benton C. The low mean score on the Non-Verbal B supports Benton's hypothesis that knowing the verbal labels for the concepts of left and right is essential when the more complex levels of left-right discrimination are involved. This appears to be true even when the verbal labels of left and right are not used in the instructions for the tasks on the test, as in the Non-Verbal B. No child in the sample made a perfect score on the Non-Verbal B. The left-right discrimination required for this test seemed to be beyond the ability of the majority of the children in the sample.

There was very little variance on the untimed Non-Verbal C, with most of the pupils scoring very high (mean 11.74 out of 12, standard deviation 1.01).

While most of the children were able to replicate the words, it was interesting to observe the difference in time required by different children to perform this task.

Some children could lay out their words in just a few seconds, while others required as long as two minutes for one word. The children who were slower in this subtest had the most difficulty picking out such letters as 'p', 'b', 'd', and 'g'. This would suggest less well developed visual perception in these children, particularly figure-ground and form constancy where letters were concerned.

The Non-Verbal C might have more value as a diagnostic tool if it were timed and a note made of children who took a much longer time to copy the words. The direction in which the children laid out the letters might also have some diagnostic value, as ten children laid the letters down in incorrect order, even though the finished word was correct.

Most of the children also scored high on the Non-Verbal D (mean 8.51 out of 10, standard deviation 1.86).

The distribution of scores on the Non-Verbal totals one and two (Appendix E) reflected the high scores of pupils on the Non-Verbal A, C, and D.

The pupils were classed as confused or discriminating on the basis of the median of the Non-Verbal total one and of the Non-Verbal total two, with 45 percent confused and 55 percent discriminating on each total (Table 11).

The tasks on the Non-Verbal were very easy for the pupils in the sample, as indicated by their high scores on the Non-Verbal A, C, and D, and totals one and two and their moderately high score on the Non-Verbal B, thus a proportion of 55 percent discriminating seems very low for this test.

Table 11

Percentage of Confused and Discriminating Pupils on the Non-Verbal Total One and Two

Sample Sub-Groups	Representation of Sub-Groups on: Non-Verbal Total One N	%	Non-Verbal Total Two N	%	Number of Children Making no Errors on Non-Verbal B	Order of Laying Down not from Left to Right on Non-Verbal C
Confused	26	45	26	45		
Discriminating	31	55	31	55		
Total	57	100	57	100	0	10

The results on the Non-Verbal might indicate an inadequacy in the method used to classify the children as confused or discriminating on this test. Using the median as a cut-off point would mean that though the median might be higher or lower the percentage of children classified as confused or discriminating would always be about the same, regardless of the level of left-right discrimination ability of the pupils. The static proportion of confused and discriminating pupils on the Non-Verbal is therefore an artifact of the definitions of confused and discriminating pupils.

Mirror Reversals. Based on ongoing research while this study was in progress, the present researcher felt that mirror reversals (Appendix E) on tests of left-right discrimination might have some diagnostic value for children

retarded in reading. Hence, mirror reversals were recorded in this study.

Nearly twice as many children made mirror reversals on the Non-Verbal total as on the Benton total (Table 12).

Table 12

Percentage of Pupils Making Mirror Reversals on the Benton and Non-Verbal Tests

Sample Sub-Groups	Pupil Performance: Benton Total		Non-Verbal Total Two	
	N	%	N	%
Mirror Reversals	19	33.3	35	61.2
No Mirror Reversals	38	66.7	22	38.8
Total	57	100.0	57	100.0

About 61 percent made mirror reversals on the Non-Verbal compared with about 33 percent on the Benton. Most of the mirror reversals were made on the Non-Verbal B and on the Benton B and C, a finding which concurred with Benton's (1959) hypothesis that while knowing the verbal labels for left and right is not necessary to discriminate left and right on the child's own body, these verbal labels are necessary before the child can achieve the more complex levels of left-right discrimination, such as are required to discriminate left and right on a person facing him.

Comparisons and Summary

Comparisons. A comparison of the percentage of

confused and discriminating pupils reported by Annand (1971) and Smith (1970) shows that on the Benton A only half as many children were confused in 1971 as in 1970, while the proportion of children who were discriminating increased by 20 percent (Table 13). The distribution of scores in Smith's sample, however, showed a pattern similar to that reported by Annand.

A pattern of change in left-right discrimination ability is evident from Table 14, which extends Table 13, in that some pupils moved from confused to consistently reversing while others moved from consistently reversing to discriminating. This would appear to support Benton's hypothesis that left-right discrimination ability is hierarchical in nature, with the ability to attach the correct verbal labels to the left and right sides of the body being highest on the continuum.

It was interesting to note that the proportion of children who were consistently reversing on the Benton A was the same in 1971 as in 1970 (Table 13), although only one child (pupil ID number 41) was consistently reversing on the Benton A in both 1970 and 1971 (Table 14).

Since a consistent left-to-right movement of the eyes is necessary for higher reading achievement and since left-right discrimination ability might aid these correct eye movements, it might be useful to know whether there is a pattern of development of left-right discrimination ability in the present sample of children where the pupils might

Table 13

Comparison and Summary of Pupil Performance on the Benton as Reported by Annand (1971) and Smith (1970)

Tests	Total Possible Score	Research Study Reported: Annand (1971) Pupil Scores	Smith (1970) Pupil Scores
Benton A	24		
Mean		18.96	17.33
Standard Deviation		8.05	8.15
Percentage:			
Confused		19.3	38.4
Discriminating		70.2	51.6
Consistently Reversing		10.5	10
Benton B	4		
Mean		1.86	1.63
Standard Deviation		1.91	1.73
Percentage:			
Confused		57.9	71.6
Discriminating		42.1	28.4
Benton C	4		
Mean		1.11	1.04
Standard Deviation		1.41	1.12
Percentage:			
Confused		92.9	96.7
Discriminating		7.1	3.3
Benton Total	32		
Mean		21.86	20.01
Standard Deviation		8.94	8.53

Table 14

Comparison of the Performance of Ten Pupils Who Were Consistently Reversing in 1970 or in 1971

Pupil ID Numbers	Performance on *Benton A*: 1970 Confused	1970 Consistently Reversing	1970 Discriminating	1971 Confused	1971 Consistently Reversing	1971 Discriminating
26	Yes				Yes	
30	Yes				Yes	
53	Yes				Yes	
5		Yes				Yes
56		Yes				Yes
57		Yes				Yes
58		Yes				Yes
41		Yes			Yes	
24			Yes		Yes	
32			Yes		Yes	

move from confused to consistently reversing to discriminating over a period of more than one year.

The increase in the percentage of discriminating pupils on the Benton B (13 percent increase) and the Benton C (4 percent increase) was not so great as the increase on the Benton A (Table 13). At a mean age of seven years ten months the pupils were still having difficulty in correctly identifying the left and right lateral body parts of an outline drawing of a man facing them.

Annand (1971) and Smith (1970) reported similar findings on the Non-Verbal subtests and total scores (Table 15) with most of the pupils scoring very high on the Non-Verbal A, C and total one and moderately low on the Non-Verbal B. Smith reported nearly the same percentage of pupils who were confused and discriminating on the Non-Verbal total one as were found in 1971. This proportion did not seem to reflect a true state of affairs, as noted previously, because the pupils' classification was based on the Non-Verbal median which rose as the children scored higher on the Non-Verbal subtests. The static percentage of discriminating pupils was, then, an artifact of the definitions of confused and discriminating pupils on this test.

Smith did not use the Non-Verbal D so no comparison with the 1971 results on that test could be made.

Annand (1971) reported a higher mean score on the Non-Verbal total one than Smith (1970) reported; no comparisons could be made with the Non-Verbal total two which contained

Table 15

Comparison and Summary of Pupil Performance on the Non-Verbal as Reported by Annand (1971) and Smith (1970)

Tests	Total Possible Score	Research Study Reported: Annand (1971) Pupil Scores	Smith (1970) Pupil Scores
Non-Verbal A	10		
Mean		9.95	9.83
Standard Deviation		0.29	0.58
Non-Verbal B	8		
Mean		3.72	2.38
Standard Deviation		2.60	2.69
Non-Verbal C	12		
Mean		11.74	11.75
Standard Deviation		1.01	0.95
Non-Verbal Total One	30		
Mean		25.47	23.89
Standard Deviation		3.00	3.06
Percentage:			
Confused		45	51.6
Discriminating		55	48.4
Non-Verbal D	10		
Mean		8.5	
Standard Deviation		1.86	
Non-Verbal Total two	40		
Mean		33.98	
Standard Deviation		3.76	
Percentage:			
Confused		45	
Discriminating		55	

the scores of the Non-Verbal D, a new subtest added by the present researcher.

Smith did not report mirror reversals on the Benton or the Non-Verbal so no comparisons with these proportions could be made.

Summary. The majority of pupils scored very high on the Benton A, Benton B and on the Benton total (Table 13). The majority scored very low on the Benton C.

The distribution of scores reported by Smith (1970) had a pattern similar to that of the present study but only half as many children were confused on the Benton A in 1971 as in 1970 (Table 13).

On the Non-Verbal, most of the pupils scored very high on the Non-Verbal A, C, D, and totals one and two (Table 15). Most of them scored moderately low on the Non-Verbal B. Forty-five percent were classified as confused and 55 percent as discriminating on both the Non-Verbal total one and total two (Table 15).

Nearly twice as many children made mirror reversals on the Non-Verbal total as on the Benton total.

PUPIL PERFORMANCE ON TESTS OF LATERAL DOMINANCE

The performance of pupils on three tests of lateral dominance, the:

1. Harris Tests of Lateral Dominance
2. Extensibility
3. Extensibility Two

is reported in this section.

In addition, the 1971 pupil performance on these tests is compared with the 1970 pupil performance as reported by Smith.

Harris Tests of Lateral Dominance

Most of the pupils showed a preferential use of their right lateral body parts (Table 16). An overwhelming proportion was:

1. Established right-eyed (84 percent)
2. Established right-footed (78 percent)
3. Right-handed for writing (89.5 percent)

The majority of pupils was also established right-eyed (61 percent), while 37 percent were established left-eyed.

Only a small percentage had incomplete dominance of hand or eye, while a larger proportion (15 percent) was incomplete-footed.

More pupils had crossed dominance, 54.4 percent, than had established lateral dominance, 45.6 percent (Table 17). The high percentage of crossed dominance reflected the high proportion of left-eyedness concomitant with a preponderance of right-handedness.

Ongoing reading while this study was in progress lead the present researcher to subdivide the crossed dominant group into crossed dominance one and crossed dominance two (Appendix E), mainly so that the crossed hand and eye pupils could be delineated. The proportion of crossed hand-eye

Table 16

Percentage of Pupils with Established Left, Established Right, and Incomplete Dominance, and Hand Used for Writing on the *Harris*

Dominance of Total Sample	Classification:							
	Handedness		Hand Used to Write		Eyedness		Footedness	
	N	%	N	%	N	%	N	%
Established:								
Left	5	8.8	6	10.5	20	36.8	4	7.0
Right	48	84.2	51	89.5	35	61.4	44	77.7
Incomplete	4	7.0	0	0	2	1.8	9	15.9
Total Number	57	100.0	57	100.0	57	100.0	57	100.0

Table 17

Percentage of Pupils with Established and Crossed Dominance on the *Harris*

Total Sample of Pupils	Classification: Established	Crossed Dominance One	Crossed Dominance Two	Total Crossed	Total in Sample
N	26	8	23	31	57
%	45.6	14.0	40.4	54.4	100.0

dominance, 40.4 percent, was about the same as the 37.7 percent of crossed hand-eye dominance reported by Harris (1957).

Extensibility

About twice as many children held their right hand higher which indicated control by the left cerebral hemisphere. When the hand held highest and the writing hand were compared, 66.4 percent of the pupils had consistent extensibility and 33.6 percent had inconsistent extensibility (Table 18).

Table 18

Percentage of Pupils Showing Consistency and Inconsistency on the Extensibility

Pupil Subgroups	Dominance: N	%
Total Sample:		
Consistent	38	66.4
Inconsistent	19	33.4
Total	57	100.0
Subsample:		
Consistent	37	72.6
Inconsistent	14	27.4
Total	51	100.0

A discrepancy between cerebral dominance, as indicated by the arm extension test (Extensibility) which was used by Smith (1970) based upon Silver and Hagin's (1960) description of Hoff and Schilder's (1927) arm extension test

which was written in German, and the hemisphere which was dominant for writing as measured by the Harris, constituted inconsistent extensibility in this study.

Extensibility Two

Information gained while the present study was in progress prompted the present researcher to re-examine the study by Silver and Hagin (1960) to see if a different interpretation of their study were warranted. Accordingly, a copy of the book by Hoff and Schilder (1927) was procured and a translation of their description of the arm extension test obtained. The translation of this description (Hoff and Schilder, 1927, p. 38) follows:

> . . . . It must also be pointed out that there comes [sic] with the normal child very often by stretching forward of the arms there results [sic] spontaneously an elevation tendency of the right hand. And further, the basic attempt with the turning of the head to the right side usually shows up far stronger in the child than when turning the head to the left. This phenomena appears already at the time when the use of the right and of the left hand is a fairly equal one, and were to be evaluated in the sense of a primary preponderance more so on the right side of the body than on the left . . . . (Schilder, 1927, p. 38) Translated by S. L. Quo.*

According to present writer's interpretation, the Extensibility as used by Smith (1970) and Silver and Hagin (1960), was a test of lateral dominance in that it indicated which hand normally would be used for fine movements such as writing. It was a test of cerebral dominance in that it indicated which hand would normally control hand-writing

---

*Assistant Professor of German at the University of Lethbridge, Lethbridge, Alberta.

which is partly a language function. The Extensibility related lateral dominance to cerebral dominance by indicating whether the hand used for writing was consistent with the hand which is held higher and, according to Hoff and Schilder (1927), is the preferred hand.

Silver and Hagin did not define precisely what they meant by 'cerebral dominance'. However, they talked about children with reading disability who had "a specific retardation in the language area," so it may be assumed that by 'cerebral dominance' they meant the hemisphere which controls the language function.

This imprecision in Silver and Hagin's (1960) report of their research made the exact replication of their test and the interpretation of the results extremely difficult. However, since Silver and Hagin (1960) reported results that would make this test practically diagnostic of reading disability due to some inconsistency of cerebral dominance and lateral dominance, a second interpretation of the children's performance on the Extensibility test was made, based on the present researcher's interpretation of Silver and Hagin (1960) and upon Hoff and Schiler's (1927) description of their test from which Silver and Hagin extrapolated their method. Other interpretations might also have been possible.

This second interpretation was called the Extensibility Two test (Appendix G), in which the terms consistent dominant and inconsistent dominant were used (Appendix E);

a third classification, incomplete dominant, was added (Appendix E). The third term was in agreement with Silver and Hagin (1960) and was used because in certain cases in the present study there was a barely-noticeable difference between the children's two hands when extended in front of them. In the Extensibility Two the terms used to describe the children's performance were:

1. Consistent dominant, which meant that the child held his preferred hand for writing as measured by the Harris more than one centimeter higher than his other hand

2. Inconsistent dominant, which meant that the child held his preferred hand for writing as measured by the Harris more than one centimeter lower than his other hand

3. Incomplete dominant, which meant that there was one centimeter or less between the child's two hands.

The results using these classifications are reported in Table 19 which shows that about the same proportion of pupils had consistent dominance and incomplete dominance, while about half as many had inconsistent dominance, on the Extensibility Two, based upon the total sample of fifty-seven pupils. In the subsample, that is the fifty-one pupils who were administered the Gates-MacGinitie, Primary B, the proportions of consistent and incomplete dominance were greater, while the proportion of inconsistent dominant pupils decreased by about 5 percent (Table 19).

The Extensibility (Table 18) did not provide for the incomplete dominant group, that is, the group who held their

Table 19

Percentage of Pupils Showing Consistent, Inconsistent, and Incomplete Dominance on the Extensibility Two Test

Total Sample of Pupils	Dominance: N	%
Extensibility Two (N=57)		
Consistent Dominant	22	38.6
Inconsistent Dominant	12	21
Incomplete Dominant	23	40.4
Subsample of pupils: (N=51)		
Extensibility Two*		
Consistent Dominant	22	43.1
Inconsistent Dominant	8	15.8
Incomplete Dominant	21	41.1

*The proportion of consistent, inconsistent, and incomplete dominant pupils in the subsample is reported here, as this data is used in later statistical analyses.

hand one centimeter or less apart when they extended their arms, considered to be a barely-noticeable difference, and hence not great enough to classify a child as inconsistent. Silver and Hagin (1960) reported that 74 percent of the pupils in their reading disability group elevated a different hand than their writing hand, and were thus inconsistent dominant. Delineation of this inconsistent dominant group was considered crucial in the present study, as this classification was practically diagnostic of reading disability in the Silver and Hagin study, hence the third classification.

Comparisons and Summary

Comparisons. A change in the pattern of lateral dominance characteristics in this sample of children over a one-year period was evident when the findings of Annand (1971) and Smith (1970) were compared.

Smith (1970) reported about the same proportion of established and incomplete handedness and eyedness as was found in the present study (Table 20), but reported twice as much left-footedness and one-third as much incomplete-footedness, however.

Belmont and Birch (1963) reported a similar preponderance of right-handed children (76 percent) and a comparable proportion of left-handed children (10 percent) as were found in the 1971 study.

Smith reported more established lateral dominance and less crossed dominance than was found in the present

Table 20

Comparison and Summary of Pupil Performance on the Harris as Reported by Annand (1971) and Smith (1970)

Lateral Dominance	Research Study Results: Annand (1971) N N=57	%	Smith (1970) N N=60	%
Harris (N=57)				
Handedness:				
Left established	5	8.8	7	11.6
Right established	48	84.2	50	83.3
Incomplete dominance	4	7.0	3	5.1
Eyedness:				
Left established	20	36.8	19	31.7
Right established	35	61.4	39	65.0
Incomplete	2	1.8	2	3.3
Footedness:				
Left established	4	7.0	8	13.3
Right established	44	77.7	49	81.7
Incomplete	9	15.9	3	5.0
Established Lateral Dominance:	26	45.6	37	63.3
Crossed Dominance:	31	54.4	23	36.7
Crossed Dominance One	8	14.0		
Crossed Dominance Two	23	40.4		

study (Table 20). He reported about the same proportion of consistent and inconsistent extensibility as was found in 1971 using the Extensibility (Table 21).

The increase in crossed dominance in 1971 reflected the increased number of pupils with incomplete dominance of hand and foot in 1971. Pupils who had any incomplete dominance were classed as crossed dominant as suggested by Harris (1958) when only two classifications, established lateral dominance and crossed dominance, were used. Thus an increase in incomplete dominant pupils would mean an increase in pupils with crossed dominance. Belmont and Birch (1963) also reported an increase of incomplete dominance of hand in six-, seven- and eight-year-old children, as was found by Annand (1971).

About the same proportion of consistent and inconsistent extensibility, as measured by the Extensibility, was reported by both Annand and Smith. No comparison with the Extensibility Two was possible as Smith did not use this test.

Summary. Most of the pupils showed preferential use of their right lateral body parts on the Harris (Table 20). A preponderance were:

1. Established right-handed
2. Established right-footed.

A large percentage was also established right-eyed.

On the Extensibility, 66 percent of the pupils in the

Table 21

Comparison and Summary of Pupil Performance on the Extensibility and the Extensibility Two as Reported by Annand (1971) and Smith (1970)

Lateral Dominance	Research Study Results: Annand (1971) N	%	Smith (1970) N	%
Extensibility (N=57)				
Consistent Extensibility	38	66.4	42	70.0
Inconsistent Extensibility	19	33.4	18	30.0
Extensibility Two (N=57)				
Consistent Dominant	22	38.6		
Inconsistent Dominant	12	21		
Incomplete Dominant	23	40.4		
Extensibility Two (N=51)				
Consistent Dominant	22	43.1		
Inconsistent Dominant	8	15.8		
Incomplete Dominant	21	41.1		

total sample had consistent extensibility, while about half as many had inconsistent extensibility. In the subsample, that is the group of fifty-one pupils who were administered the Gates-MacGinitie, Primary B, a larger proportion of pupils were consistent, while about 6 percent less were inconsistent.

The proportion of consistent dominant and the proportion of incomplete dominant pupils, as measured by the Extensibility Two, was about the same in the total sample (Table 21), while about half as many had inconsistent dominance. In the subsample, the proportions of consistent and incomplete dominance were greater, while the proportion of inconsistent dominant pupils decreased by about 5 percent.

Smith (1970) reported about the same proportions of established and incomplete handedness and eyedness among pupils in the first year of school as were found in the present study among pupils in the second year of school (Table 20), but reported more established lateral dominance and less crossed dominance than was found in the present study.

DIFFERENCES BETWEEN PUPIL PERFORMANCE ON VARIOUS TESTS IN 1971 AND 1970

In this section the 1971 pupil performance was compared with the 1970 pupil performance on tests of:

1. Reading achievement
2. Left-right discrimination
3. Lateral dominance
4. Verbal ability

5. Visual perception

using the following statistical analyses:

1. Correlated t-tests for:

   Differences in scores on the above tests

2. Z-Tests for correlated proportions for:

   Differences in proportions of pupils who were classed as having various lateral dominance characteristics according to the:

   a. Harris

   b. Extensibility

   c. Extensibility Two and:

      Various left-right discrimination characteristics according to the:

      (1) Benton

      (2) Non-Verbal

Correlated T-Tests

The significant improvement in the 1971 pupil scores over the 1970 scores on the Neale, WISC, Non-Verbal B, Non-Verbal total one, and Frostig subtests: II (figure-ground), III (constancy of shape), IV (position in space), V (spatial relationships) and total (Table 22) could be expected. The significantly lower score on the Frostig I (eye-motor coordination) in 1971 may reflect the moderate test-retest reliability of the Frostig, an average of .60 for the subtests and .80 for the perceptual quotient (Buros, 1965), which can be caused by differences in stringency of marking, particularly

Table 22

Correlated T-Tests for the Significance of the Difference Between the Means of the Neale, WISC, Benton, Subtest and Total, Frostig Subtests and Total, 1971 and 1970

Tests	Means 1971	Means 1970	Computations: T-Test Values for Means	P
Neale	30.81	18.35	11.22	0.00
WISC	27.51	17.67	14.11	0.00
Benton:				
A	18.97	17.04	1.40	0.17
B	1.86	1.60	0.97	0.34
C	1.11	1.02	0.41	0.68
Total	21.86	19.65	1.54	0.13
Non-Verbal:				
A	9.95	9.83	1.55	0.13
B	3.72	2.45	3.11	0.00
C	11.74	11.74	0.00	1.00
Total One	25.47	23.95	3.40	0.00
Frostig:				
I	18.21	21.03	-4.50	0.00
II	18.44	12.60	12.83	0.00
III	11.37	8.22	6.20	0.00
IV	7.04	6.46	5.50	0.00
V	6.77	6.23	3.35	0.00
Total	62.37	54.51	7.16	0.00

in the eye-motor coordination subtest.

That there was no significant change in the _Non-Verbal A_ reflects that nearly all of the pupils made a perfect score on this test both years.

That there was no significant difference in the _Benton_ subtests or total scores, even though a significantly greater proportion were classed as discriminating on the _Benton A_ in the second year of school (Table 23), reflects the method of classifying the pupils as discriminating. The pupils who became discriminating in 1971 may have scored twenty-one on the _Benton A_ in 1970 which would result in their being classed as confused. A score of twenty-two would put them in the discriminating class in 1971, but would not raise the _Benton A_ mean score significantly. The change in the proportions of pupils that were discriminating on the _Benton B_ and _C_ in the first year of school and the second year of school was not significant, according to the correlated z-tests (Table 23), which further confirms the results of the correlated t-tests.

Z-Tests

When the proportion of children who were confused and discriminating on the _Benton A_ in 1971 was compared with the proportion who were so classified in 1970 there was a significant increase in the number of children who were discriminating in 1971 compared with 1970 (Table 23). This showed that the pupils in the sample were significantly better at distinguishing the left and right sides of their

Table 23

Z-Tests for Proportions of Correlated Samples 1970 and 1971

Tests (N=57)	Pupils Who in 1970 were: and	Who in 1971 were:		Z - Value
		Inconsistent	Consistent	
<u>Extensibility</u>:	Consistent	13	27	0.40 n.s.
	Inconsistent	6	11	
		Crossed	Established	
<u>Harris</u>:	Established	11	23	1.80 n.s.
	Crossed	19	4	
		Left-Handed	Right-Handed	
<u>Harris</u>: Handedness:	Right-Handed	0	45	1.00 n.s.
	Left-Handed	3	0	
		Incomplete-	Right-	
	Right-	3	0	0.00 n.s.
	Incomplete-	0	3	
	Left-	1	0	1.00 n.s.
	Incomplete	0	2	

Table 23 (continued)

Tests	Pupils Who in 1970 were:	and Who in 1971 were:		Z-Value
Harris:		Left-	Right-	
Eyedness:	Right-	7	29	1.26 n.s.
	Left	13	3	
		Incomplete-	Right-	
	Right-	1	0	0.58 n.s.
	Incomplete	0	2	
		Incomplete-	Left-	
	Left-	2	0	1.41 n.s.
	Incomplete	0	0	
Harris:		Left-	Right-	
Footedness:	Right-	1	39	1.00 n.s.
	Left-	3	3	
		Incomplete-	Right-	
	Right-	5	0	1.13 n.s.
	Incomplete	1	2	
		Incomplete-	Left-	
	Left-	3	0	1.73 n.s.
	Incomplete-	0	0	

Table 23 (continued)

Tests	Pupils Who in 1970 were: and	Who in 1971 were:		Z-Value
		Discriminating	Confused	
<u>Benton A:</u>	Confused	12	8	2.32*
	Discriminating	23	3	
		Consistently Reversing	Confused	
	Confused	3	0	1.73 n.s.
	Consistently Reversing	0	0	
		Consistently Reversing	Discriminating	
	Discriminating	2	0	1.33 n.s.
	Consistently Reversing	1	5	
		Confused	Discriminating	
<u>Benton B:</u>	Confused	14	27	1.79 n.s.
	Discriminating	10	6	
		Discriminating	Confused	
<u>Benton C:</u>	Confused	5	44	0.33 n.s.
	Discriminating	4	4	
		Discriminating	Confused	
<u>Non-Verbal</u> Total One	Confused	12	18	0.89 n.s.
	Discriminating	19	8	

*Significant at beyond .05 level

own bodies in 1971 than in 1970. Twelve of the children who were confused in 1970 had become discriminating in 1971; eight who were confused in 1970 remained confused in 1971; twenty-three who were discriminating in 1970 remained discriminating in 1971; three who were discriminating on the Benton A in 1970 had become confused in 1971.

There were no other significant differences between the proportions of pupils who were established dominant or incomplete dominant on the Harris, established lateral dominant or crossed dominant on the Harris, consistent or inconsistent on the Extensibility, and confused or discriminating on the Benton B or C, or on the Non-Verbal total one.

PUPIL PERFORMANCE ON TESTS OF READING ACHIEVEMENT

In this section the performance of pupils on the:

1. Neale Analysis of Reading Ability
2. Gates-MacGinitie Reading Tests (Vocabulary and Comprehension) is reported.

Furthermore, the 1971 pupil performance on these tests is compared with the 1970 pupil performance as reported by Smith.

Neale Analysis of Reading Ability

The pupil's scores on the Neale indicated that they were generally above average in oral reading achievement for their ages; the reading age equivalent for the raw mean score of 30.81 (Table 24) is 8.3 years (Neale, 1969), while the

mean chronological age of the pupils was 7.10 years. The standard deviation was 12.83 which indicated that the majority of pupils' scores fell within a fairly wide range.

Table 24

Comparison of Pupil Performance on the Neale as Reported by Annand (1971) and Smith (1970)

Calculations for the Neale	Research Study Reported: Annand (1971)	Smith (1970)
Mean	30.81	18.05
Standard Deviation	12.83	8.17
Total Possible	100.00	100.00
Mean Reading Age	8.3	7.4

Gates-MacGinitie Reading Tests

In silent reading the mean grade level of the subsample of fifty-one pupils who were given the Gates-MacGinitie, Primary B, in June, 1971, was about eight months ahead of their grade placement in vocabulary and about six months ahead in comprehension (Table 25).

Comparisons and Summary

A comparison of the pupils' 1971 mean Neale scores with those reported by Smith (1970) showed that the pupils' mean reading age increased by 0.9 between May, 1970, and May, 1971 (Table 24), which was less than one year's advance over 1970. The majority of pupils' scores fell within a wider range in 1971 than in 1970.

Table 25

Means and Standard Deviations of Pupil Performance on the Gates-MacGinitie

Calculations	Pupil Performance: Gates-MacGinitie Primary B, Form I (N=51) 1971		Gates-MacGinitie Primary A, Form I (N=57) 1970	
	Vocabulary	Comprehension	Vocabulary	Comprehension
Means	38.78	26.39	35.70	22.74
Standard Deviations	7.48	5.94	13.63	9.40
Total Possible	48	34	48	34
Mean Grade Score	3.7	3.6	2.0	2.1

A comparison with the performance of the total sample of fifty-seven pupils in June, 1970, showed that the mean score on the Gates-MacGinitie, Primary A then was only one month above grade placement on vocabulary and two months ahead in comprehension (Table 25). Furthermore, the standard deviation indicated a much wider range of scores in 1970 than in 1971. The removal of the five lowest readers from the total sample in the 1971 testing which resulted in the sub-sample of fifty-one pupils created a much more homogenous, higher achieving group as regards silent reading. Even so, the mean of the subsample advanced less than one grade level in the one-year period between the 1970 and 1971 testing on the Gates-MacGinitie.

PUPIL PERFORMANCE ON A TEST OF VERBAL ABILITY

This section presents findings on the performance of pupils on the Wechsler Intelligence Scale for Children, vocabulary subtest.

In addition, the 1971 pupil performance on this test is compared with the 1970 pupil performance as reported by Smith.

The WISC Vocabulary Subtest

The mean pupil score of 27.51 (Table 25) was equivalent to a scaled score of 12, which placed the pupils in a slightly above average range for this age group (Wechsler, 1949).

Comparison. A comparison of pupils' 1971 WISC vocabulary subtest scores with those reported by Smith (1970) indicated that last year the pupils' verbal ability was about average for their age. The 1971 standard deviation of 6.40 was about the same as that of 1970 (5.13) (Table 26).

Table 26

Comparison and Summary of Pupil Performance on the WISC as Reported by Annand (1971) and Smith (1970)

Calculations for the WISC	Research Study Reported: Annand (1971)	Smith (1970)
Mean	27.51	17.43
Standard Deviation	6.40	5.13
Total Possible	80.00	80.00
Scaled Score	12 (approx.)	9 (approx.)

PUPIL PERFORMANCE ON A TEST OF VISUAL PERCEPTION

In this section the performance of pupils on the Marianne Frostig Development Test of Visual Perception is reported, as is a comparison of the 1971 and 1970 pupil performance.

The pupils were slightly below average in visual perceptual ability for their mean age as indicated by the mean perceptual quotient (Frostig *et al.*, 1966, p. 40). A perceptual quotient of 97 (Table 27) falls between the fortieth and fiftieth percentile (Frostig *et al.*, p. 32) as

Table 27

Means and Standard Deviations of Neale, WISC, Vocabulary Subtest, and Frostig, Subtests and Total Scores of Pupils

Calculations: Total Pupil Sample (N=57)	Pupil Performance: Neale	WISC Vocabulary Subtest	Frostig Subtests I	II	III	IV	V	Total	Frostig Mean Perceptual Quotient
Means	30.81	27.51	18.21	18.44	11.37	7.40	6.77	62.37	97
Standard Deviations	12.83	6.40	3.49	2.04	2.89	.70	.82	6.63	
Total Possible	100	80	30	20	17	8	8	83	125
Reading Age Equivalent	8.3								
Scaled Score on WISC		12							

determined by the standardization sample.

<u>Comparison and Summary</u>. The pupils in the sample were slightly below average in visual-perceptual ability, as indicated by the mean perceptual quotient of 97 (Table 28). This perceptual quotient is lower than that reported by Smith (1970) for the pupils in his sample (105) when they were six years ten months old. The score on the <u>Frostig</u> subtest I was also lower in 1971 than in 1970.

It would be expected that pupils would score higher on the <u>Frostig</u> in 1971 than in 1970. That they did not may be a reflection of the moderate test-retest reliability of the <u>Frostig</u>, an average of .60 for the subtests, (Buros, 1965) and an average of .80 for the perceptual quotient, in that exact replication of the instructions would be difficult because of the manner in which they are phrased. There might also be a difference in the stringency of marking, especially for subtest I.

Table 28

Comparison and Summary of Pupil Performance on the Frostig as Reported by Annand (1971) and Smith (1970)

Frostig Subtest	Possible Score	Research Study Reported: Annand (1971) Pupil Score	Smith (1970) Pupil Score
Calculations:			
I: Eye-Motor Co-ordination:	30		
Mean		18.21	21.28
Standard Deviation		3.49	4.11
II: Figure-Ground:	20		
Mean		18.44	12.61
Standard Deviation		2.04	3.14
III: Constancy of Shape:	17		
Mean		11.37	8.18
Standard Deviation		2.89	3.68
IV: Position in Space:	8		
Mean		7.40	6.46
Standard Deviation		.70	1.30
V: Spatial Relations:	8		
Mean		6.77	6.21
Standard Deviation		.82	1.20
Total:	83		
Mean		62.37	54.73
Standard Deviation		6.63	9.42
Mean Perceptual Quotient:		97	105
Total Possible Perceptual Quotient:		125	

CHAPTER V

FINDINGS OF THE STUDY: RELATIONSHIPS AMONG PUPIL PERFORMANCE ON TESTS OF LEFT-RIGHT DISCRIMINATION AND OTHER TESTS

In chapter five, the findings of the study are discussed under the following headings:

1. Relationships between pupil performance on:

   Two tests of left-right discrimination

2. Relationships among pupil performance on tests of:

   a. Intellectual ability

   b. Reading achievement

   c. Verbal ability

   d. Visual perception

3. Relationships between pupil performance on:

   Tests of left-right discrimination and each of:

   a. Intellectual ability

   b. Reading achievement

   c. Verbal ability

   d. Visual perception

RELATIONSHIPS BETWEEN PUPIL PERFORMANCE ON TWO TESTS OF LEFT-RIGHT DISCRIMINATION

In this section the relationships between pupil performance on the:

1. <u>Benton Test of Right-Left Discrimination</u>

2. Non-Verbal Test of Directional Confusion are discussed under the following headings:

1. Correlations

   Benton and Non-Verbal subtests and total

2. Chi-square frequency:

   Mirror reversals on the Benton and Non-Verbal

Correlations

Pupils who made lower scores in copying nonsense syllables in the Non-Verbal C tended to score higher on pointing to the lateral body parts of an outline picture of a man facing them on the Benton C (Table 29). Even though these children did not have the visual-perceptual ability to accurately choose letters which are easily confused, such as 'b' and 'd' and 'p' and 'q', their strongly developed extrapersonal directional sense would help them to compensate for their visual-perceptual deficits and their reading achievement would possibly not be affected as severely as might otherwise be the case. Although the negative relationship reached statistical significance, however, only 9 percent of the test variance on the Benton C could be predicted from the Non-Verbal scores because the correlation was only -0.31.

The significant positive correlation between the Benton A and the Benton C concurs with Benton's (1959, p. 143) finding that children who were better able to discriminate left and right on their own bodies made the transposition in identifying the lateral body parts of a person facing them

Table 29

Correlations Between Tests of Left-Right Discrimination

Test	Correlations: 1	2	3	4	5	6	7	8	9	10
(N=57)										
1. Benton A	1.00	0.00	0.29*	0.92**	-0.11	0.23	-0.04	0.17		
2. Benton B		1.00	0.64**	0.30*	-0.07	0.01	-0.24	-0.09	0.08	-0.02
3. Benton C			1.00	.55**	0.06	0.06	-0.31*	-0.06	-0.03	-0.07
4. Benton Total				1.00	-0.10	0.21	-0.14	0.12	0.07	0.13
5. Non-Verbal A					1.00	-0.11	0.01	0.00	-0.14	-0.06
6. Non-Verbal B						1.00	0.26*	0.91**	0.10	0.78**
7. Non-Verbal C							1.00	0.56**	0.20	0.54**
8. Non-Verbal Total One								1.00	0.14	0.85**
9. Non-Verbal D									1.00	0.60**
10. Non-Verbal Total Two										1.00

*Significance at .05 level

**Significance at .01 level

more often than children who did not perform well on the Benton A tasks, and thus it could be anticipated that high scores on the Benton C would be associated with high scores on the Benton A. That there was no association between high scores on the Benton A and the Benton B, which like the Benton C required a transposition in order to identify the lateral body parts of a man in an outline drawing facing the child, also concurs with Benton's (1959, p. 143) finding that some children whose own body discrimination was perfect could not make the transposition required to correctly identify the lateral body parts of a person facing them. This was found in the present study.

Chi-Square Frequency

The relationship between the proportion of pupils who made mirror reversals on the Non-Verbal total two and mirror reversals on the Benton total was not significant (Table 30). Even though the relationship was not significant, it is interesting to note that while only seven of the pupils who made no mirror reversals on the Non-Verbal made mirror reversals on the Benton, twenty-three of the pupils who made mirror reversals on the Non-Verbal made no mirror reversals on the Benton. This finding would seem to give support to Benton's hypothesis that knowing the meaning of the verbal labels for left and right is necessary to correctly perform the more complex left-right discrimination. In the Non-Verbal no verbal labels were used in giving directions on the various subtests which would mean that the pupils did not

have the help which verbal labels would have given when they attempted to perform the complex tasks on the Non-Verbal B, and hence many of them made mirror reversals on this subtest, which accounted for most of the mirror reversals on the Non-Verbal.

Table 30

Relationship Between Mirror Reversals on the Non-Verbal Total Two and Mirror Reversals on the Benton

Non-Verbal	Benton: Mirror Reversals on Benton	Benton: No Mirror Reversals on Benton	Total
No Mirror Reversals on Non-Verbal	7	15	22
Mirror Reversals on Non-Verbal	12	23	35
Total (N=57)	19	38	57

df = 1 Chi-Square = 0.04 n.s.

Comparisons

Smith (1970) found significant positive correlations between Benton and Non-Verbal subtests (Table 31). None of the same correlations were found in the present study, but a significant negative correlation between the Benton C and Non-Verbal C was found.

Smith did not report mirror reversals on the Benton or Non-Verbal so no comparisons with these could be made.

Table 31

Comparison of Correlations Between Tests of Left-Right Discrimination as Reported by Annand (1971) and Smith (1970)

	Research Study Reported:			
	Annand (1971)		Smith (1970)	
Significant Correlation Between	Significant	Level of Significance	Significant	Level of Significance
Benton C and:				
Non-Verbal C (negative)	Yes	.05	No	
Benton A and:				
Non-Verbal A	No		Yes	.05
Non-Verbal C	No		Yes	.05
Benton Total and:				
Non-Verbal A	No		Yes	.05
Non-Verbal C	No		Yes	.05

RELATIONSHIPS AMONG PUPIL PERFORMANCE ON TESTS OF INTELLECTUAL ABILITY, READING ACHIEVEMENT, VERBAL ABILITY AND VISUAL PERCEPTION

This section presents findings on the relationship between pupil performance on a test of intellectual ability, the Lorge-Thorndike Intelligence Tests, Level Two, two tests of reading achievement, the:

1. Neale Analysis of Reading Ability
2. Gates-MacGinitie Reading Tests, Primary B, Vocabulary and Comprehension,

a test of verbal ability, the Wechsler Intelligence Scale for Children, vocabulary subtest, and a test of visual

perception, the Marianne Frostig Developmental Test of Visual Perception, under the following headings:

1. Correlations
2. Comparisons

Correlations

Pupils who had high intellectual ability tended to score high on tests of oral and silent reading ability, verbal ability and visual perception (Tables 32 and 33), while those who scored high on tests of oral and silent reading achievement also scored high on tests of visual perception (Table 34). Conversely, pupils who scored low on one of these tests also scored low on the others.

Comparisons

Smith (1970) did not report these correlations so no comparisons could be made.

RELATIONSHIPS BETWEEN PUPIL PERFORMANCE ON TESTS OF LEFT-RIGHT DISCRIMINATION AND INTELLECTUAL ABILITY

The findings in this section report relationships between pupil performance on tests of left-right discrimination, the:

1. Benton Test of Right-Left Discrimination
2. Non-Verbal Test of Directional Orientation, and

a test of intellectual ability, the Lorge-Thorndike Intelligence Tests, Level Two, which are presented and discussed as follows:

Table 32

Correlations Between Reading Achievement, Verbal Ability and Intellectual Ability Scores

Tests	Correlations: 1	2	3	4
Total Sample: (N=57)				
1. Neale	1.00	0.58***	0.61***	
2. WISC		1.00	0.62***	
3. Lorge-Thorndike			1.00	
Sub-Sample (N=51)				
Gates-MacGinitie:				
1. Vocabulary	1.00	0.87***	0.70***	0.67***
2. Comprehension		1.00	0.60***	0.63***
3. WISC			1.00	0.60***
4. Lorge-Thorndike				1.00

	Gates-MacGinitie	
N=51	Vocabulary	Comprehension
Neale	0.66***	0.63***

***Significant at .001 level

Table 33

Correlations Between Intellectual Ability and Visual Perception

Test	Correlations: Frostig Subtests I	II	III	IV	V	Frostig Total
Total Sample: (N=57)						
Lorge-Thorndike	0.26*	0.46***	0.31**	0.32**	0.46***	0.51***

Table 34

Correlations Between Reading Achievement and Visual Perception

Tests	Correlations: Frostig Subtests I	II	III	IV	V	Frostig Total
Total Sample: (N=57)						
Neale	0.31*	0.48***	0.44***	0.20	0.28*	0.53***
Gates-MacGinitie:						
Vocabulary	0.36**	0.44***	0.37**	0.36**	0.58***	0.58***
Comprehension	0.29*	0.54***	0.32*	0.36**	0.53***	0.55***

*Significant at .05 level

**Significant at .01 level

***Significant at .001 level

1. Correlations:

   Benton and Non-Verbal subtests and totals and the:

   Lorge-Thorndike

2. Comparisons

Correlations

The ability to discriminate left and right as measured by the Benton subtests and total was not correlated with intellectual ability as measured by the Lorge-Thorndike (Table 35). This finding is difficult to explain since Benton (In Money, 1962, p. 99) stated that intellectual ability is significantly associated with left-right discrimination at all levels, but particularly at the more complex levels, and that level of intelligence must therefore always be considered when discussing left-right discrimination ability. It may be that left-right discrimination as measured by the Benton becomes correlated with intelligence as the child gets older, in much the same way as does reading achievement. As reading becomes more demanding there is a greater dependence upon the higher order cognitive processes which are involved in reasoning and interrelating of ideas, rather than upon the perceptual abilities as in the earliest stages of learning to read. Thus pupils who have higher intellectual ability generally achieve more highly in reading than children with lower intellectual ability because they can master the higher order cognitive processes.

Table 35

Correlations Between Tests of Left-Right Discrimination and Intellectual Ability

Tests	Correlations: Benton A	B	C	Total
Total Sample: (N=57)				
Lorge-Thorndike	0.08	-0.07	-0.18	0.02

	Non-Verbal A	B	C	Total One	D	Total Two
Lorge-Thorndike	0.06	0.34**	0.39**	0.42***	0.35**	0.50***

**Significant at beyond the .01 level
***Significant at beyond the .001 level

It would be interesting to investigate in another year's time whether a significant relationship between left-right discrimination as measured by the Benton and intelligence as measured by the Lorge-Thorndike had developed.

The ability to discriminate left and right following non-verbal directions on the Non-Verbal B, C, and D, and total one and two was significantly positively related to intellectual ability (Table 35), which would support Benton's (1962) contention. There was no correlation between the Non-Verbal A and intellectual ability since all of the pupils scored very high on that subtest regardless of their intellectual ability.

Comparisons

Smith (1970) did not report these correlations so no comparisons could be made.

RELATIONSHIPS BETWEEN PUPIL PERFORMANCE ON TESTS OF LEFT-RIGHT DISCRIMINATION AND TESTS OF READING ACHIEVEMENT

The relationships between the performance of pupils on tests of left-right discrimination, the:

1. Benton Test of Right-Left Discrimination
2. Non-Verbal Test of Directional Orientation,

and tests of reading achievement, the:

1. Neale Analysis of Reading Ability
2. Gates-MacGinitie Reading Tests, Primary B,

are discussed in this section under the following headings:

1. Correlations:

    Neale and Gates-MacGinitie
    (Vocabulary and Comprehension)
    and the:

        Benton and Non-Verbal, subtests
        and totals

2. One-way analysis of variance:

    Neale and Gates-MacGinitie (Vocabulary
    and Comprehension) and:

        Confused, discriminating or
        consistently reversing on the:

            Benton A

3. Analysis of Covariance:

   a. Criterion variables:

      (1) Neale mean scores

      (2) Gates-MacGinitie (Vocabulary and Comprehension) mean scores

   b. Covariates:

      (1) WISC, vocabulary subtest mean scores

      (2) Lorge-Thorndike mean scores

4. T-Tests

   a. Neale and Gates-MacGinitie (Vocabulary and Comprehension) and:

      Confused or discriminating on:

      (1) Benton B and C

      (2) Non-Verbal totals one and two

   b. Benton and Non-Verbal, subtests and totals, and:

      No reversals or any reversals on the:

         Neale

   c. Neale and Gates-MacGinitie (Vocabulary and Comprehension) and:

         No mirror reversals or any mirror reversals on the:

            Benton and Non-Verbal Totals

5. Comparisons and summary:

   a. Comparisons:

      Annand (1971) and Smith (1970)

   b. Summary

Correlations

Neale and Benton. Pupils who scored high in oral reading achievement also were high in the ability to discriminate left and right on their own bodies and possessed the correct verbal labels for left and right since they also scored high on the Benton A (Table 36). Pupils who scored high on the Neale also tended to score high on the Benton total, but only 9 percent of the variance on the Benton total could be predicted from the pupils' Neale scores and most of this would be accounted for by their Benton A scores.

However, the ability to discriminate left and right on an outline drawing of a man facing them, as measured by the Benton B and Benton C, was not significantly related to oral reading achievement. This suggests that while having a strong extrapersonal sense of directionality was necessary in order to correctly perform the tasks on the Benton B and C these same abilities were not necessary in order to score high in reading achievement on the Neale.

The results of this analysis indicate, then, that:

1. Discrimination of left and right on one's own body and having the correct verbal labels for the left and right lateral body parts are related to oral reading achievement in the second year of school, but not strongly

2. Having a strong extrapersonal sense of directionality, such as was required to correctly perform the tasks on the Benton B and C, was not necessary in order for high

Table 36

Correlations Between Tests of Left-Right Discrimination and Reading Achievement

	Correlations:									
	Benton				Non-Verbal					
Tests	A	B	C	Total	A	B	C	Total One	D	Total Two
Total Sample (57) on:										
Neale	0.30*	-0.03	0.02	0.26*	0.23	0.24	0.24**	0.30*	0.20	0.34**
Subsample (51) on:										
1. Gates-MacGinitie Vocabulary	0.15	0.05	0.03	0.14	0.33**	0.35**	0.61**	0.44**	0.36**	0.53**
2. Gates-MacGinitie Comprehension	0.11	0.00	-0.10	0.08	0.31*	0.32*	0.49**	0.44**	0.36**	0.53**

*Significant at .05 level

**Significant at .01 level

achievement on the Neale in the second year of school.

Benton (1962, p. 100) suggested that reading disability may be associated with inability to perform the more complex left-right discrimination tasks, "that is, those involving a conceptual or verbal element", but this did not seem to be the case in the sample of children in the present study. It may be that a particular type of reading disability is associated with lack of this ability, however. It may be also that the inability to perform these complex left-right discrimination tasks, such as those required in the Benton B and C where the child must identify the lateral body parts of an outline drawing of a man facing him, is associated with reading disability in older children. Further investigation of this ability in these children another year might reveal if such a trend developed.

Smith (1970) used an adaptation of Benton's scoring method as described in Benton and Kemble (1960) and Benton (1959). This adaptation made it possible to compare the reading scores of children who could: consistently discriminate left and right on their own bodies, but did not have the correct verbal labels for left and right (the consistently reversing group on the Benton A) with those who could: discriminate their own lateral body parts and who knew the correct labels for left and right (the discriminating group on the Benton A) and those who could: neither consistently discriminate left and right on their own bodies nor give the correct verbal labels for left and right (the confused group

on the Benton A).

The present researcher was committed to following Smith's method of analysis in order to determine what changes had taken place in this sample of children between May, 1970, and May, 1971. Thus Smith's adapted scoring method was used in the present study and statistical analyses were made on the basis of it.

A further analysis of the data was made by the present researcher, based upon Benton (1969), in which the reading scores of pupils who made mirror reversals (Appendix E) and those who did not were compared. T-tests of the differences between the oral and silent reading achievement means of pupils who made mirror reversals on the Benton total and Non-Verbal total and those who did not were made in the present study and are reported later in this chapter.

Neale and Non-Verbal. Pupils who scored higher on a test which did not use verbal labels for left and right in the instructions also tended to score higher in oral reading achievement (Table 36). There was a significant positive correlation between the Neale and the Non-Verbal C, which required the pupils to copy nonsense syllables laid out by the examiner, and between the Neale and the Non-Verbal totals one and two scores. The relationship was not strong, however, since only 4 percent of the total variance on the Neale could be predicted from the Non-Verbal C and only about 10 percent from totals one and two. Since scores on both the Neale and the Non-Verbal were significantly related to intellectual

ability, however, as reported previously, the higher scores which occur on these tests concurrently may be a reflection of the pupils' intellectual ability as suggested by Benton (1962), rather than of left-right discrimination ability as measured by the Non-Verbal C and totals one and two or it may reflect better developed visual discrimination in the children who score higher in both tests.

There was about the same amount of relationship between the Non-Verbal totals one and two and the pupils' reading achievement on the Neale as there was between the Benton A and the Neale which may indicate that these two subtests are analogous in measuring left-right discrimination ability. It would be interesting to see if a similar relationship continued to exist one year later.

Gates-MacGinitie and Benton. That there were no significant relationships between the silent reading ability of the pupils in the subsample and their ability to discriminate left and right as measured by any of the Benton subtests may have been because the five poorest readers in the sample were not in the subsample. They were repeating grade one and did not receive the Gates-MacGinitie, Primary B, so their scores were not used in statistical analyses involving the Gates-MacGinitie.

On the other hand, there may have been no significant relationships between the Gates-MacGinitie and any Benton subtests because directional sense as measured by the Benton

A is associated significantly only with oral reading fluency. Shepherd, as quoted by Benton (1962) reported no relationship between left-right discrimination and silent reading ability. His tests were not named. It would be interesting to investigate this relationship one year later to see if the same condition existed in this sample of pupils in their third year of school as in their second year. It might also be interesting to compare these pupils' grade one Gates-MacGinitie scores with their 1970 performance on the Benton to see if there were a relationship then.

Gates-MacGinitie and Non-Verbal. The Non-Verbal did not appear to be as sensitive to the presence of retarded readers as was the Benton as there was a significant relationship between the Gates-MacGinitie and the Non-Verbal even when the five poorest readers had been removed from the sample. This would tend to negate Shepherd's contention, as reported by Benton (1962), of no relationship between left-right discrimination and silent reading ability. There must, moreover, be some overlapping in the measuring of left-right discrimination abilities by the Benton and Non-Verbal since the Non-Verbal C and totals one and two were also significantly related to the Neale scores, as were the Benton A and total. The relationship one year later also might be interesting to investigate.

One-Way Analysis of Variance

Neale and Benton. There was a significant difference

between the Neale scores of pupils who were confused, discriminating and consistently reversing (Table 37). The Newman-Keuls tests on means showed the ordered means thus:

1. Discriminating, group 2 (40 pupils)
2. Confused, group 1 (11 pupils)
3. Consistently reversing, group 3 (6 pupils)

Table 37

One-Way Analysis of Variance Comparing Reading Scores of Confused, Discriminating and Consistently Reversing Pupil Groups on the Benton A

Tests	Computations: Summary of One-Way Analysis of Variance on Reading Scores:				
Source of Variance	SS	df	MS	F	P
1. Neale (N=57)					
Between Groups	995.93	2	499.96	3.27	0.05
Within Groups	8228.95	54	152.39		

Newman-Keuls Tests on Means

		2	1	3
	Means	33.53	24.82	23.67
3	23.67	9.86**	1.15	
1	24.82	8.71		
2	33.53			

Group 1: Confused (11 pupils)

Group 2: Discriminating (40 pupils)

Group 3: Consistently reversing (6 pupils)

Source of Variance:	SS	df	MS	F	P
2. Gates-MacGinitie, Vocabulary (N=51)					
Between Groups	395.75	2	197.87	3.95	0.03
Within Groups	2404.93	48	50.10		

Table 37 (continued)

Newman-Keuls
Tests on Means

		3	2	1
	Means	41.00	39.84	32.38
1	32.38	8.63*	7.46*	
2	39.84	1.16		
3	41.00			

Group 1: Confused (8 pupils)

Group 2: Discriminating (38 pupils)

Group 3: Consistently reversing (5 pupils)

Source of Variance:	SS	df	MS	F	P
3. Gates-MacGinitie Comprehension (N=51)					
Between Groups	145.05	2	75.52	2.19	0.12
Within Groups	1593.10	48			

Newman-Keuls:

Not necessary when the one-way analysis of variance shows no significant difference between groups.

*Significant at beyond .05 level

**Significant at beyond .01 level

The Newman-Keuls on the computer output did not show between which groups the significant difference lay because of the disparity in the size of the groups, and because the difference was significant at only the .05 level. However, the Newman-Keuls method using a studentized range distribution calculated by hand using the formula:

$$q_r = \frac{\bar{X}_A - \bar{X}_B}{\sqrt{\frac{MS\ error}{n}}}$$

revealed that the mean of the discriminating group was

significantly better than that of the confused group and of the consistently reversing group at beyond the .01 level. This indicated that being able to discriminate their own left and right lateral body parts and to attach verbal labels to them was related to the pupils' higher reading achievement on the Neale.

It may be that the discriminating group had higher intellectual ability, since as Benton suggested left-right discrimination is associated with intelligence, and that this contributed to their higher reading achievement more than did their left-right discrimination ability. High verbal ability also may have contributed to their high Neale scores.

Gates-MacGinitie, Primary B, and Benton. There was a significant difference at the .03 level between the means of the three groups, confused, discriminating and consistently reversing, on the Gates-MacGinitie, Primary B (Vocabulary) scores of the subsample of fifty-one pupils (Table 37). The Newman-Keuls tests on means showed the ordered means to be:

1. Consistently reversing, group 3 (5 pupils)
2. Discriminating, group 2 (38 pupils)
3. Confused, group 1 (8 pupils)

with a significant difference at beyond the .05 level between the mean scores of groups which were:

1. Consistently reversing and confused
2. Discriminating and confused.

The differences as noted above indicated that knowing

the meaning of the verbal labels for the left and right lateral sides of their bodies was not important for pupils to score higher on the Gates-MacGinitie vocabulary in the second year of school. Being able to consistently distinguish left and right on their own bodies was important, however, in that the consistently reversing group scored significantly higher than the confused or discriminating group on the Gates-MacGinitie vocabulary. This finding supports previous findings in this study that a different relationship exists between oral reading achievement as measured by the Neale and silent reading ability as measured by the Gates-MacGinitie and left-right discrimination as measured by the Benton A.

That there was no significant difference between the silent reading comprehension scores of confused, discriminating or consistently reversing groups on the Benton A indicates that it is possible for children to glean the correct meaning from a passage using context clues even though they might not read all of the words accurately because of some directional confusion. However, when they must read each word accurately and without the benefit of context clues, in order to choose a precise meaning for it, as in the vocabulary subtest, it is essential that they read the words in a left-to-right progression. If they tend to have directional confusion regarding their own bodies they would inaccurately identify some words through making reversal errors, even in silent reading, hence the importance of left-right discrimination, as measured by the Benton A, in

the vocabulary subtest.

Since there were no significant differences between the mean of the three groups, no Newman-Keuls tests on means were carried out, hence none are reported.

Analysis of Covariance, WISC Mean Score as Covariate

Neale as Criterion Variable. When verbal ability was covaried out the difference between the Neale mean scores of confused, discriminating and consistently reversing groups of children on the Benton A only approached significance ($p<.08$) (Table 38). Since the difference between the means approached significance a multiple comparison of variance and covariance was carried out, but it further confirmed that there was no significant differences between the Neale mean scores of any of the three groups.

Thus verbal ability was contributing partially, but not significantly, to the difference in the Neale mean scores of the three groups and, even though fluency in oral reading requires a consistent left-to-right movement of the eyes, pupils who had high verbal ability were able to compensate for any disadvantage they may have had because of directional confusion as measured by the Benton A and thus scored higher on the Neale than those who could not compensate for their left-right discrimination deficiencies.

Gates-MacGinitie, Vocabulary as Criterion Variable. There was a significant difference between the mean of the confused, discriminating and consistently reversing groups on

Table 38

Summary of Analysis of Covariance on Adjusted Reading Means
WISC Scores of Pupils as Covariate

Source of Variance	df	Computations: MS	Adj. F	P
1. Neale Scores				
Between Groups	2	276.24	2.69	0.08
Within Groups	53	102.65		
Adjusted Means:				
Group 1: 27.32				
Group 2: 32.78				
Group 3: 24.05				
Group 1: Confused				
Group 2: Discriminating				
Group 3: Consistently Reversing				
2. Gates-MacGinitie, Vocabulary Scores				
Between Groups	2	87.41	3.47	0.04
Within Groups	48	25.15		
Adjusted Means:				
Group 1: 34.48				
Group 2: 39.45*				
Group 3: 40.05*				
3. Gates-MacGinitie, Comprehension Scores				
Between Groups	2	28.53	1.29	0.28
Within Groups	4	22.08		
Adjusted Means:				
Group 1: 23.92				
Group 2: 26.79				
Group 3: 27.31				

*Significant at .05 level

the Gates-MacGinitie, Primary B, vocabulary subtest, even when verbal ability was covaried out (Table 38). A multiple comparison of variance and covariance revealed that there was a significant difference between the discriminating and confused groups, and between the consistently reversing and confused groups.

This indicated that being able to discriminate the left and right sides of their own body, with or without knowing the correct verbal labels for left and right, as measured by the Benton A, did contribute to reading achievement of the Gates-MacGinitie vocabulary subtest for the pupils in the subsample. A consistent left-to-right progression of eye movements is necessary in order to correctly identify words in silent reading without the benefit of context clues, and even having high verbal ability did not compensate for a deficit in this ability, as measured by the Benton A.

Gates-MacGinitie, Comprehension as Criterion Variable. Since there were no significant differences in the comprehension scores of pupils who were confused, discriminating or consistently reversing on the Benton A, according to the one-way analysis of variance, an analysis of covariance on these scores was not necessary. A consistent left-to-right progression of eye movements and the resultant more accurate identification of individual words was not essential for pupils to score high in comprehension in the second year of school since there are many contextual and structural clues

which aid pupils in getting meaning from a written passage.

Analysis of Covariance with Lorge-Thorndike Mean Scores as Covariate

Neale as Criterion Variable. When intellectual ability as measured by the Lorge-Thorndike was covaried out there was no significant difference between the mean Neale scores of the confused, discriminating and consistently reversing groups on the Benton A (Table 39). The difference between the mean Neale scores of these three groups approached significance, however, with the discriminating group scoring highest, so a multiple comparison of variance and covariance was carried out but revealed no significant differences between the mean Neale scores of these three groups of children in the second year of school.

Even though fluent oral reading requires a consistent left-to-right eye movement, pupils who had high intellectual ability were able to compensate for any disadvantages they may have had because of directional confusion regarding their own body parts and thus scored higher on the Neale than less bright pupils who could not compensate for their left-right discrimination deficiencies as measured by the Benton A.

Gates-MacGinitie, Vocabulary, as Criterion Variable. There was no significant difference between the Gates-MacGinitie, Vocabulary, mean scores of the three groups (confused, discriminating and consistently reversing on the Benton A) when intellectual ability was covaried out (Table

Table 39

Summary of Analysis of Covariance on Adjusted Means with the Mean Scores on the Lorge-Thorndike as Covariate

Source of Variance	df	Computations: MS	Adj. F	P
1. Neale				
Betweeen Groups	2	261.11	2.71	0.08
Within Groups	53	96.21		
Adjusted Means:				
Group 1: 26.81				
Group 2: 32.78				
Group 3: 25.00				
Group 1: Confused				
Group 2: Discriminating				
Group 3: Consistently Reversing				
2. Gates-MacGinitie, Vocabulary				
Between Groups	2	81.45	2.89	0.07
Within Groups	47	28.17		
Adjusted Means:				
Group 1: 34.69				
Group 2: 39.36				
Group 3: 40.91				
3. Gates-MacGinitie, Comprehension				
Between Groups	2	22.34	1.08	0.35
Within Groups	47	20.71		
Adjusted Means:				
Group 1: 24.53				
Group 2: 26.69				
Group 3: 27.53				

39). The difference approached significance, however ($p<.08$), with the discriminating group placing highest and the confused group lowest, so a multiple comparison of variance and covariance was carried out, but revealed no significant difference between the means of any of the three groups.

Even though a consistent left-to-right movement of the eyes is necessary in order to read each word accurately without the benefit of context or structural clues, pupils who had high intellectual ability were able to compensate for any disadvantages they may have had because of directional confusion as measured by the Benton A and thus scored higher on the Gates-MacGinitie vocabulary, than those who could not compensate for the left-right discrimination deficiencies through higher intellectual ability.

Gates-MacGinitie, Comprehension, as Criterion Variable. There was no significant difference between the Gates-MacGinitie comprehension scores of confused, discriminating or consistently reversing groups on the Benton A according to the one-way analysis of variance, so no analysis of covariance was necessary. The pupils could abstract the correct meaning from a passage using context and structural clues even though they might not read all of the words accurately because of some directional confusion.

T-Tests

Benton and Reading Achievement. That the ability to discriminate left and right on an outline drawing of a man

facing them as measured by the Benton B and Benton C was not necessary for high reading achievement on the Neale for pupils in the second year of school was further indicated by the findings of these statistical analyses (Table 40). There were no significant differences in the oral reading scores of pupils who were confused or discriminating on the Benton B and C. Both of these tests involve complex tasks of left-right discrimination which require an understanding of the verbal concepts of left and right and which require a strong sense of extrapersonal directionality, which means that the pupils can tell left and right on objects or persons outside of their own bodies.

There were also no significant differences in the Gates-MacGinitie vocabulary and comprehension scores of pupils who were confused or discriminating on the Benton B or C.

It would appear, then, that the ability to perform the more complex left-right discrimination tasks such as being able to tell left and right on a person facing them was not crucial to the pupils' oral or silent reading achievement, as measured by the Neale and Gates-MacGinitie, in the second year of school. Clark (1970) reported that 60 percent of the children in her sample, which was taken from a normal school population, made a score of three or less out of five questions on her test of left-right discrimination so concluded that lack of such discrimination was not important in learning to read.

Table 40

T-Tests Comparing the Reading Scores of Groups which were Confused or Discriminating on the Benton Subtests and on the Non-Verbal Totals

		Computations:				
Tests	N	Means	S.D.	df	T	P
Neale (N=57)						
Benton B						
Confused	33	31.18	12.51	55	0.26	0.80
Discriminating	24	30.29	13.52			
Benton C						
Confused	53	31.02	12.84	55	0.45	0.65
Discriminating	4	28.00	14.28			
Non-Verbal Total One						
Confused	26	28.19	14.07	55	-0.67	0.16
Discriminating	31	33.00	11.47			
Non-Verbal Total Two						
Confused	25	27.20	13.98	55	-1.92	0.06
Discriminating	32	33.62	11.30			
Gates-MacGinitie Vocabulary (N=51)						
Benton B						
Confused	30	38.40	7.34	49	0.43	0.66
Discriminating	21	39.33	7.84			
Benton C						
Confused	47	38.91	7.45	49	0.42	0.67
Discriminating	4	37.25	8.85			
Non-Verbal Total One						
Confused	23	36.17	9.11	49	-2.35	0.02
Discriminating	28	40.93	5.05			

Table 40 (continued)

Tests	N	Means	Computations: S.D.	df	T	P
Non-Verbal Total Two						
Confused	22	35.32	8.75	49	-3.12	0.00
Discriminating	29	41.41	5.10			
Gates-MacGinitie Comprehension (N=51)						
Benton B						
Confused	30	26.37	6.05	49	-0.03	0.97
Discriminating	21	26.43	5.82			
Benton C						
Confused	47	26.64	5.70	49	1.02	0.31
Discriminating	4	23.54	8.27			
Non-Verbal Total One						
Confused	23	24.09	6.87	49	-2.68	0.01
Discriminating	28	28.29	4.21			
Non-Verbal Total Two						
Confused	22	28.82	6.72	49	-2.91	0.01
Discriminating	29	28.34	4.37			

The difference between the Neale scores of groups that were confused or discriminating on the Non-Verbal total two approached, but did not reach significance (Table 40). This may reflect the correlation between the Non-Verbal, and the Neale and intellectual ability as reported earlier, or it may mean that the visuospatial abilities measured by the Non-Verbal are important in quickly and accurately identifying letters and words, a skill which is necessary for fluent oral reading.

Non-Verbal and Reading Achievement. That the difference between the silent reading scores of pupils in the subsample who were confused or discriminating on a non-verbal test of left-right discrimination was significant could reflect the high correlation between the Non-Verbal and the Gates-MacGinitie and intellectual ability, as reported earlier. Pupils who were more intelligent scored higher on both these tests. Pupils whose score was equal to or greater than the median on the Non-Verbal were classed as discriminating. Therefore the students who were above the mean of the subsample in intellectual ability would likely be classed as discriminating, while those who were below the mean in intellectual ability would be likely to be classed as confused. Similarly, pupils who had higher intellectual ability would score higher on the Gates-MacGinitie while those with less intellectual ability would score lower. Hence a significant difference between the Gates-MacGinitie scores of confused and discriminating pupils could be anticipated.

Benton and Non-Verbal and Reversal Errors on the Neale. That pupils who made reversal errors on the _Neale_ scored significantly higher on the _Benton B_ (Table 41) may appear to be contradictory. However, such may not be the case.

Reversal errors in oral reading usually indicate directional confusion, according to Harris (1970, p. 243), but it may be that the type of directional confusion which they represent is the important element. The _Benton B_ tests a pupil's ability to discriminate left and right on an outline drawing of a man facing him and following verbal directions. Whether or not pupils were confused or discriminating on the _Benton B_ made no difference to their reading scores according to t-tests carried out in the present study, so it appears that this ability is not important to high oral reading achievement in the second year of school.

Reversal errors in oral reading may be indicative of problems in reading, so it is therefore not contradictory that pupils who made reversal errors on the _Neale_ scored higher on the _Benton B_, since the _Benton B_ did not predict reading achievement in this sample.

A highly significant difference ($p<.001$) was found between the _Non-Verbal A_ scores of pupils who made no reversal errors on the _Neale_ and those who made reversal errors. Those who made reversal errors on the _Neale_ made significantly lower scores on the _Non-Verbal A_. That pupils who made reversal errors on the _Neale_ scored significantly

Table 41

T-Tests Comparing Scores on the Benton, Subtests and Total and the Non-Verbal, Subtests and Totals of Groups Who Made No Reversal Errors on the Neale with Those Who Made Reversal Errors

Tests (N=57)	N	Means	Computations: S.D.	df	T	P-Two Tail
Benton A						
No reversals	54	19.13	7.79	55	0.65	0.52
Reversals	3	16.00	13.86			
Benton B						
No reversals	54	1.74	1.90	55	-2.05	0.05
Reversals	3	4.00	0.00			
Benton C						
No reversals	54	1.11	1.45	55	0.13	0.90
Reversals	3	1.00	0.00			
Benton Total						
No reversals	54	21.91	8.78	55	0.17	0.87
Reversals	3	21.00	13.86			
Non-Verbal A						
No reversals	54	9.98	0.14	55	4.24	0.00
Reversals	3	9.33	1.15			
Non-Verbal B						
No reversals	54	3.69	2.60	55	-0.42	0.68
Reversals	3	4.33	3.06			
Non-Verbal C						
No reversals	54	11.72	1.04	55	-0.46	0.64
Reversals	3	12.00	0.00			
Non-Verbal Total One						
No reversals	54	25.46	3.05	55	-0.11	0.91
Reversals	3	25.67	2.31			
Non-Verbal D						
No reversals	54	8.48	1.90	55	-0.47	0.64
Reversals	3	9.00	1.00			
Non-Verbal Total Two						
No reversals	54	33.94	3.83	55	-0.32	0.75
Reversals	3	34.67	2.52			

lower on the Non-Verbal A may reflect a directional confusion associated with interhemispheric rivalry, as suggested by Orton's (1937) neurological theory. It may on the other hand reflect a conflict in motor tendencies as suggested by Dearborn's (1931) theory, or it may be a reflection of these children's visual-perceptual abilities, or a constellation of many factors.

Reading Achievement and Mirror Reversals. Pupils who made no mirror reversals (Appendix E) on the Benton scored significantly higher ($p = .02$) on the Neale than those who made mirror reversals (Table 42). This may indicate that there is some complex relationship between left-right discrimination and reading achievement on the Neale even though pupils who had firmly established left-right discrimination, with the correct verbal labels, in identifying their own lateral body parts did not achieve significantly higher in oral reading when verbal or intellectual ability was covaried out.

That there was no significant difference in the Gates-MacGinitie scores between the group that made no mirror reversals on the Benton and the group that made mirror reversals concurs with a previous finding that knowing the correct verbal labels for the left and right sides of the body was not necessary for high achievement on the Gates-MacGinitie, a silent reading test. Fluency in oral reading, and hence the avoidance of errors, requires a consistent left-to-right eye movement, but in silent reading the child

Table 42

T-Tests Comparing Scores on the Neale and Gates-MacGinitie, Vocabulary and Comprehension of Groups that Made: No Mirror Reversals with Those of Groups that Made Mirror Reversals on the Benton Total and Non-Verbal Total Two

Tests (N=57)	N	Computations: Means	S.D.	T	P
Benton:					
Neale N=57					
No mirror reversals	38	33.63	13.86	2.45	0.02
Mirror reversals	19	25.16	8.19		
Gates-MacGinitie:					
N=51					
Vocabulary					
No mirror reversals	37	39.11	7.64	0.50	0.62
Mirror reversals	14	37.93	7.27	0.08	0.93
Comprehension					
No mirror reversals	37	26.43	6.13	0.08	0.93
Mirror reversals	14	26.29	5.46		
Non-Verbal:					
Neale N=57					
No mirror reversals	22	33.64	11.32	1.33	0.19
Mirror reversals	35	29.03	13.56		
Gates-MacGinitie:					
N=51					
Vocabulary					
No mirror reversals	21	40.29	6.27	1.20	0.23
Mirror reversals	30	37.73	8.17		
Comprehension					
No mirror reversals	21	27.38	5.02	1.00	0.32
Mirror reversals	30	25.70	6.43		

can have numerous regressions without these back and forth eye movements being noticed unless his reading behavior is being photographed. These regressions would slow down the child's silent reading and lower his reading efficiency, but would not reduce his score as seriously in silent reading as in oral reading, hence there were no significant differences in the silent reading scores of pupils who made mirror reversals on the Benton.

There were no significant differences in the Neale or Gates-MacGinitie reading scores of pupils who made no mirror reversals or mirror reversals on the Non-Verbal. More than half of the children made mirror reversals on the Non-Verbal, so it did not differentiate between high and low reading achievers. Perhaps some difference would show up if the children were older, with the ones who continued to make mirror reversals being differentiated from those who did not.

Comparisons and Summary

Pupils who scored high in oral reading achievement in the second year of school also were high in the ability to discriminate left and right on their own bodies and possessed the correct verbal labels for left and right. When verbal or intellectual ability was covaried out the difference was not significant, however; children who were high in these abilities were able to compensate for any deficits in oral reading to which confusion between left and right on their own bodies may have contributed.

Smith (1970) reported that the discriminating group on the Benton A scored significantly higher in oral reading than the confused group even when verbal ability was covaried out (Table 43). These findings were regarded as indicating that there was a significant relationship between the pupils' ability to discriminate between the right and left sides of their own bodies as measured by the Benton A and their reading achievement as measured by the Neale in the first year of school. He did not covary out intellectual ability.

Annand (1971) on the other hand found that the discriminating group on the Benton A scored significantly higher on the Neale, but when verbal ability or intellectual ability was covaried out the difference disappeared.

The differences in these findings indicated that being able to consistently label their left and right lateral body parts was very important to these children in the earliest stages of learning to read, and that at the end of their second year in school the relationship still existed but in a slightly different way.

Harris (1970) reported on the 1968 study of Cohen and Glass who found that good readers scored significantly better on left-right discrimination, as measured by a four-item subtest in the Harris, than poor readers in grade one, but that in grade four there was no significant relationship. The present longitudinal-type study seems to indicate that a similar trend is developing in the pupils in this study.

Table 43

Comparison and Summary of Pupil Performance on the Neale, Gates-MacGinitie, Benton, and Non-Verbal as Reported by Annand (1971) and Smith (1970)

	Research Study Reported:			
	Annand (1971)		Smith (1970)	
Tests	Significant	Level of Significance	Significant	Level of Significance
Significant Relationship Between:				
Neale and:				
Benton A	Yes	.05	Yes	.05
Benton C	None		Yes	.05 (negative)
Benton total	Yes	.05	None	
Non-Verbal A	None		Yes	.05
Non-Verbal C	Yes	.05	None	
Non-Verbal Total One	Yes	.05	None	
Non-Verbal Total Two	Yes	.05	Not reported	
Gates-MacGinitie, Vocabulary and:			Gates-MacGinitie test not in Smith's study.	
Non-Verbal A, B, C, D, and totals one and two	Yes	.01		
Gates-MacGinitie, Comprehension and:				
Non-Verbal A and B	Yes	.05		
Non-Verbal C, D, and totals one and two	Yes	.01		

Table 43 (continued)

Tests	Annand (1971) Signifi-cant	Annand (1971) Level of Signifi-cance	Smith (1970) Signifi-cant	Smith (1970) Level of Signifi-cance
Significant Difference Between:				
Neale mean scores of: Confused, discriminating and consistently reversing groups on the Benton A	Yes	.01	Yes	.01
	Discriminating group higher than confused or consistently reversing groups		Discriminating group higher than confused group	
When verbal ability covaried out	No	.08	Yes	.03
When IQ covaried out	No	.08	Not reported	
Gates-MacGinitie, Vocabulary, mean scores of: Consistenly reversing and discriminating groups better than confused group on Benton A	Yes	.03		
When verbal ability covaried out	Yes	.05		
Gates-MacGinitie, Comprehension, mean scores of: Confused, discriminating, consistently reversing groups	No			
Neale mean scores of: Discriminating and confused groups on Benton B and C	NO		No	

Table 43 (continued)

Tests	Research Study Reported: Annand (1971) Significant	Annand (1971) Level of Significance	Smith (1970) Significant	Smith (1970) Level of Significance
Confused and discriminating on Non-Verbal totals one and two	No		No	
Gates-MacGinitie mean scores of: Confused and discriminating groups on the Non-Verbal			Gates-MacGinitie test not in Smith's study.	
Gates-MacGinitie, Vocabulary and Comprehension, mean scores of: Discriminating and confused groups on Benton B and C	No			
Gates-MacGinitie, Vocabulary and Comprehension, mean scores of: Discriminating and confused groups on the Non-Verbal totals one and two	Yes	$p = .02$ $p = .01$		

Table 43 (continued)

Tests	Annand (1971) Significant	Annand (1971) Level of Significance	Smith (1970) Significant	Smith (1970) Level of Significance
Significant Difference Between Benton and Non-Verbal scores of:				
No reversal errors on the Neale and reversal errors on the Neale:				
Between Benton A scores	No		Yes	$p<.05$ Reversal errors group lower score
Between Benton B scores	Yes	$p<.05$ Reversal errors group higher	Yes	$p<.01$ Reversal errors group higher
Between Non-Verbal Total scores	Yes	$p<.001$ Reversal errors group lower	No	

Both Annand (1971) and Smith (1970) reported significant positive correlations between oral reading achievement and left-right discrimination as measured by the Benton and the Non-Verbal (Table 43).

Both Annand and Smith found no significant difference in the oral reading scores of groups of pupils who were confused or discriminating on the Benton B and C.

Annand and Smith each found that pupils who made reversal errors in oral reading scored higher on the _Benton B_. Annand regarded this as not contradictory since the _Benton B_ scores were not associated with high reading achievement of children in the second year of school.

Annand found that pupils who made no mirror reversals on the _Benton_ scored significantly higher on the _Neale_ than those who made mirror reversals, possibly indicating some complex relationship between left-right discrimination ability and reading achievement. There was no significant difference between these groups' scores on the _Gates-MacGinitie_. There were also no significant differences between the _Neale_ or _Gates-MacGinitie_ scores of pupils who had no mirror reversals or mirror reversals on the _Non-Verbal_.

RELATIONSHIPS BETWEEN PUPIL PERFORMANCE ON TESTS OF LEFT-RIGHT DISCRIMINATION AND VERBAL ABILITY

The section discusses relationships between tests of left-right discrimination, the:

1. _Benton Test of Right-Left Discrimination_
2. _Non-Verbal Test of Directional Orientation_

and a test of verbal ability, the _Wechsler Intelligence Scale for Children_, Vocabulary Subtest, under these headings:

1. Correlations:

   Benton and _Non-Verbal_ and:

   WISC

2. One-Way Analysis of Variance:

   WISC and:

   Confused, discriminating or consistently reversing on the:

   Benton A

3. T-Tests:

   WISC and:

   a. Confused or discriminating on the:

      (1) Benton B and C

      (2) Non-Verbal totals one and two

   b. No mirror reversals or mirror reversals on the:

      (1) Benton total

      (2) Non-Verbal total

4. Comparisons and Summary

   Annand (1971) and Smith (1970)

Correlations

Achievement on the Benton subtests and total cannot be predicted from scores on the WISC since there were no significant correlations between them (Table 44).

Benton (1959) hypothesized that if children could not correctly perform the left-right discrimination tasks which involved the identification of the lateral body parts of persons facing them they may be retarded in their language function. If this is true, then it appears that very few children in the sample had sufficient ability in symbolic

Table 44

Correlations Between Tests of Left-Right
Discrimination and Verbal Ability

Tests Total Sample (N=57)	Correlations: Benton A	B	C	Total
WISC	0.13	0.02	0.02	0.10

	Non-Verbal A	B	C	Total One	D	Total Two
WISC	0.07	0.14	0.38**	0.25	0.19	0.29*

*Significant at .05 level
**Significant at .01 level

representation to perform the complex left-right discrimination tasks on the Benton B and C since there was no correlation between their verbal ability and their scores on these two subtests. Even though the children in the sample were above average in verbal ability for their age they still had not mastered verbal concepts well enough to achieve highly on the Benton B and C. If Benton's hypothesis were correct a correlation between the WISC and the Benton A could not be anticipated, since the lowest level of left-right discrimination, that of identifying one's own body parts is a sensorimotor function which depends upon tactual, proprioceptive and visual components but not upon symbolic representation.

Only about 14 percent of the variance on the *Non-Verbal C* and about 8 percent on the *Non-Verbal* total two could be predicted from the *WISC*, even though the correlation was significant, so there does not seem to have been a strong relationship between left-right discrimination and verbal ability.

One-Way Analysis of Variance

Further support for a conclusion of no significant relationship between verbal ability and left-right discrimination in the second year of school was given by the finding of no significant difference in the *WISC* scores of confused, discriminating or consistently reversing groups on the *Benton A* (Table 45).

Table 45

One-Way Analysis of Variance Comparing Verbal Ability Scores of Groups that were Confused, Discriminating or Consistently Reversing on the *Benton A*

Tests	Computations: Summary of One-Way Analysis of Variance on *WISC* scores:				
Source of Variance	SS	df	MS	F	P
WISC					
Between Groups	73.45	2	36.72	0.89	0.41
Within Groups	2216.80	54	41.05		

This finding appears to be contrary to that of Benton (1959, p. 142) who reported that children who were

consistently reversing in identifying their own lateral body parts were generally lower in verbal ability. It may be that this relationship becomes important when the children are older than those in the present sample and still cannot attach the correct verbal labels to the left and right sides of their bodies.

It may also indicate that a more powerful statistic, such as a priori statistics (Ferguson, 1959, p. 295) which are built into the design of the study, might be more suitable for analyzing some of the data in a study such as the present one. This type of statistic could not be used in the present study because the present researcher was following the method used by Smith (1970) so that direct comparisons with his results could be made.

T-Tests

Further evidence that the pupils' verbal ability had no significant relationship to their level of left-right discrimination was given by the findings that were no significant differences in the WISC scores of groups that were confused or discriminating on the Benton B or C nor on the Non-Verbal (Table 46), nor between the groups that made no mirror reversals or any mirror reversals on tests of left-right discrimination (Table 47).

Comparisons and Summary

There was a change in the relationships between verbal ability and reading achievement in 1971 as compared

Table 46

T-Tests Comparing WISC Scores of Groups that were Confused or Discriminating on the Benton B, Benton C, and Non-Verbal Totals One and Two

Tests (N=57)	N	Means	Computations: S.D.	T	P
Benton B					
Confused	33	27.30	5.50	-0.28	0.77
Discriminating	24	27.79	7.57		
Benton C					
Confused	53	27.57	6.15	0.24	0.80
Discriminating	4	26.75	10.34		
Non-Verbal Total One					
Confused	26	26.88	6.97	-0.67	0.50
Discriminating	31	28.03	5.94		
Non-Verbal Total Two					
Confused	25	25.88	6.59	-1.73	0.08
Discriminating	32	28.78	6.04		

Table 47

T-Tests Comparing Scores on the WISC of Groups Who Made No Mirror Reversals on the Benton or Non-Verbal with the Scores of Those Who Made Mirror Reversals

Tests (N=57)	N	Means	Computations: S.D.	DF	F	P-Two Tail
WISC						
No Mirror Reversals	38	28.05	6.77	55	0.91	0.37
Any Mirror Reversals	19	26.42	5.57			

with 1970, in that there was no significant differences in the WISC vocabulary subtest scores of pupils who were confused, discriminating or consistently reversing on the Benton A in their second year of school as reported by Annand (1971).

Smith (1970), on the other hand, reported that the consistently reversing group scored significantly higher in verbal ability than the confused group, but not significantly higher than the discriminating group. He reported no correlations between the children's WISC scores and any Benton subtests however. It seems that the ability to discriminate the left and right sides of their own bodies is important for children to score high in verbal ability in the first year of school, but not in the second.

Neither Annand nor Smith found any significant differences between the verbal ability scores of groups of pupils that were confused or discriminating on the Benton B or C (Table 48), which indicates that knowing the meaning of the verbal labels for left and right and being able to identify the lateral body parts of an outline drawing of a man facing them was not important for the acquisition of word meanings as measured by the WISC in this sample of children in either their first or second year of school.

The relationships between the WISC and the Non-Verbal were not strong in either 1971 or 1970, for even though both Annand and Smith found significant correlations between the Non-Verbal and the WISC only 10 percent or less of the variance on the WISC could be predicted from the correlated

Table 48

Comparisons and Summary of Relationships Between Pupils' Performance on the Benton and Non-Verbal and on the WISC

Tests	Research Study Reported: Annand (1971) Significant	Annand (1971) Level of Significance	Smith (1970) Significant	Smith (1970) Level of Significance
Significant Correlations Between:				
WISC and:				
Non-Verbal C	Yes	.01	No	
Non-Verbal total one	No		Yes	.05
Non-Verbal total two	Yes	.05	No	
Significance of difference between WISC scores of:				
1. Confused discriminating consistently reversing groups on the: Benton A	No		Yes Consistently reversing group higher than confused group	.01
2. Confused or discriminating groups on the Benton B and C	No		No	

Non-Verbal score either year.

Neither Annand nor Smith found any significant differences between the verbal ability scores of groups that were confused or discriminating on the Non-Verbal giving further evidence of very little relationship between left-right discrimination as measured by this test and verbal ability as measured by the WISC in this sample of children.

RELATIONSHIPS BETWEEN PUPIL PERFORMANCE ON TESTS OF LEFT-RIGHT DISCRIMINATION AND VISUAL PERCEPTION

The findings in this section report relationships between pupil performance on tests of left-right discrimination, the:

1. Benton Test of Right-Left Discrimination
2. Non-Verbal Test of Directional Orientation

and a test of visual perception, the Marianne Frostig Developmental Test of Visual Perception, which are discussed as follows:

1. Correlations:

   Frostig Subtests and Total and:

   Benton and Non-Verbal Subtests and totals

2. One-Way Analysis of Variance:

   Frostig Subtests and Total and:

   Confused or discriminating on the:

   Benton A

3. T-Tests:

   Frostig Subtests and Total and:

   Confused or Discriminating on the

   a. Benton B and C

   b. Non-Verbal Totals One and Two

4. Comparisons and Summary:

   a. Comparisons:

      Annand (1971) and Smith (1970)

   b. Summary

Correlations

Left-right discrimination ability on the Benton cannot be predicted from visual-perceptual scores on any Frostig subtest nor the total in these pupils in the second year of school, since there were no significant correlations between scores on these tests (Table 49).

This finding in this final section of this chapter shows that scores on the Benton bear very little, if any, relationship to scores on any other test in this chapter, the only significant correlation being with oral reading achievement as reported previously.

On the other hand, left-right discrimination as tested by the Non-Verbal correlated highly in a number of instances with visual perception as tested by the Frostig. The same visuospatial abilities appear to be required in order to perform the tasks which are correlated with each other. None of the Non-Verbal subtests were correlated with

Table 49

Correlations Between *Benton* Subtests and Total Scores and *Non-Verbal* Subtests and Total Scores and *Frostig* Subtests and Total Scores

Tests (N=57)	Correlations: Benton			
	A	B	C	Total
Frostig I	0.21	-0.03	0.05	0.18
Frostig II	0.11	-0.11	-0.10	0.06
Frostig III	-0.02	0.14	0.06	0.00
Frostig IV	0.03	-0.15	0.01	0.00
Frostig V	-0.01	-0.07	-0.12	-0.04
Frostig Total	0.15	0.01	0.00	0.13

	Non-Verbal					
	A	B	C	Total	D	Total
Frostig I	0.31**	0.21	0.33**	0.32**	0.18	0.34**
Frostig II	0.42**	0.19	0.24	0.28*	0.42**	0.44**
Frostig III	0.13	0.16	0.21	0.22	0.11	0.23
Frostig IV	0.10	0.20	0.32**	0.28*	0.29*	0.37**
Frostig V	0.02	0.41**	0.47**	0.50**	0.48**	0.64**
Frostig Total	0.18	0.35**	0.44**	0.47**	0.39**	0.56**

*Significant at .05 level

**Significant at .01 level

the Frostig III (constancy of shape), however, and the Non-Verbal A and B were each correlated with only two Frostig subtests. The correlations with the Non-Verbal C are particularly interesting since this test involved copying nonsense syllables by placing magnetic letters on a metal tray. Most of the pupils scored very high on the Non-Verbal C, but those who did not, according to these correlations, were poor in the Frostig subtests which measured: eye-motor coordination, figure-ground perception, position in space and spatial relationships and had a low perceptual quotient as derived from the Frostig total.

One-Way Analysis of Variance

That there were no significant differences in the Frostig subtests and total scores of groups that were confused, discriminating or consistently reversing on the Benton A (Table 50), gave further evidence that status on the Benton A did not affect visual-perceptual scores. However, the difference on the Frostig V (spatial relations) approached significance indicating that the pupils' level of left-right discrimination did have some effect upon their ability to copy simple forms and patterns following dots as guidepoints.

T-Tests

More evidence that there was no significant relationship between the left-right discrimination as measured by the Benton and visual-perceptual ability in pupils in the second year of school was given by there being no significant

Table 50

One-Way Analysis of Variance Comparing Visual-Perceptual Scores of Confused, Discriminating or Consistently Reversing Pupil Groups on the Benton A

Tests (N=57) Computations: Summary of Analysis of Variance on Frostig Scores:					
Source of Variance	SS	df	MS	F	P
Frostig I					
Between Groups	34.63	2	17.32	1.45	0.24
Within Groups	646.84	54	11.98		
Frostig II					
Between Groups	5.69	2	2.84	0.67	0.51
Within Groups	228.35	54	4.23		
Frostig III					
Between Groups	17.60	2	8.80	1.06	0.35
Within Groups	449.67	54	8.33		
Frostig IV					
Between Groups	0.28	2	0.14	0.28	0.76
Within Groups	27.43	54	0.51		
Frostig V					
Between Groups	3.76	2	1.88	2.96	0.06
Within Groups	34.27	54	0.63		
Frostig Total					
Between Groups	95.25	2	47.63	1.09	0.34
Within Groups	2366.06	54	43.82		

differences between the Frostig subtests and total scores of pupils who were confused or discriminating on the Benton B and C (Table 51).

Left-right discrimination as measured by the Non-Verbal, however, was significantly related to visual-perceptual ability in that there were significant differences on several Frostig subtests between the mean scores of groups that were confused or discriminating on the Non-Verbal totals one and two, with the discriminating group scoring higher in each case (Table 51). Others approached significance. These differences could be because both the Frostig and the Non-Verbal were significantly related to intellectual ability, or because the same visuospatial ability was required to perform well on each of these tests. These differences have relevance for reading in that the difference in the mean Neale scores of pupils who were classed as confused or discriminating on the Non-Verbal total two approached significance as reported previously, with the discriminating group scoring higher.

Comparisons and Summary

In neither the first nor second year of school could left-right discrimination as measured by the Benton be used to predict visual-perceptual ability, since there were no significant correlations between any of the Frostig and Benton subtests or the totals.

Table 51

T-Tests Comparing Frostig Subtest and Total Scores of Pupils Who Were Confused or Discriminating on the Benton B, Benton C, or Non-Verbal Totals One and Two

Comparison of Confused and Discriminating Groups on Benton B with Scores On:

Tests (N=57)	N	Means	S.D.	T	P
		Computations:			
Frostig I					
Confused	33	18.25	3.01	1.00	0.92
Discriminating	24	18.16	4.09		
Frostig II					
Confused	33	18.50	1.81	0.25	0.80
Discriminating	24	18.36	2.34		
Frostig III					
Confused	33	11.03	2.83	-1.00	0.32
Discriminating	24	11.80	2.96		
Frostig IV					
Confused	33	7.44	0.67	0.41	0.68
Discriminating	24	7.36	0.76		
Frostig V					
Confused	33	6.75	0.92	-0.23	0.82
Discriminating	24	6.80	0.71		
Frostig Total					
Confused	33	61.97	5.67	-0.51	0.61
Discriminating	24	62.88	7.78		

Comparison of Confused and Discriminating Groups on Benton C with Scores on:

Tests (N=57)	N	Means	S.D.	T	P
Frostig I					
Confused	53	18.30	3.41	0.72	0.47
Discriminating	4	17.00	3.83		
Frostig II					
Confused	53	18.55	1.96	1.47	0.15
Discriminating	4	17.00	2.94		

Table 51 (continued)

Tests	Computations: N	Means	S.D.	T	P
Frostig III					
Confused	53	11.43	2.92	0.26	0.53
Discriminating	4	10.50	2.65		
Frostig IV					
Confused	53	7.43	0.64	1.19	0.24
Discriminating	4	7.00	1.41		
Frostig V					
Confused	53	6.81	0.81	1.32	0.15
Discriminating	4	6.25	0.96		
Frostig Total					
Confused	53	62.72	6.13	1.46	0.15
Discriminating	4	57.75	11.76		
Comparison of Confused and Discriminating Groups on Non-Verbal Total One with Scores On:					
Frostig I					
Confused	26	17.08	3.29	-2.33	0.01
Discriminating	31	19.16	3.42		
Frostig II					
Confused	26	17.85	2.29	-2.06	0.04
Discriminating	31	18.94	1.69		
Frostig III					
Confused	26	10.92	2.84	-1.06	0.29
Discriminating	31	11.74	2.92		
Frostig IV					
Confused	26	7.23	0.76	-1.72	0.08
Discriminating	31	7.55	0.62		
Frostig V					
Confused	26	6.42	0.99	-3.15	0.002
Discriminating	31	7.06	0.51		
Frostig Total					
Confused	26	59.46	7.18	-3.29	0.001
Discriminating	31	64.81	5.06		

Table 51 (continued)

Tests	N	Means	S.D.	T	P
		Computations:			
Comparison of Confused and Discriminating Groups on Non-Verbal Total Two with Scores on:					
Frostig I					
Confused	26	17.38	3.43	-1.67	0.10
Discriminating	31	18.90	3.44		
Frostig II					
Confused	26	17.81	2.26	-2.20	0.03
Discriminating	31	18.97	1.70		
Frostig III					
Confused	26	11.04	2.93	-0.70	0.43
Discriminating	31	11.65	2.87		
Frostig IV					
Confused	26	7.23	0.76	-1.73	0.08
Discriminating	31	7.55	0.62		
Frostig V					
Confused	26	6.42	0.99	-3.15	0.002
Discriminating	31	7.06	0.51		
Frostig Total					
Confused	26	59.85	7.42	-2.79	0.007
Discriminating	31	64.48	5.10		

Smith, however, found some relationship between left-right discrimination on the Benton and visual perception in that there was a significant difference in the mean Frostig scores on some subtests between groups which were confused, discriminating or consistently reversing on the Benton A and groups which were confused or discriminating on the Benton B with the discriminating group scoring higher. These relationships seemed to have disappeared by 1971, however,

since Annand found no significant differences in any *Frostig* subtests between any of the pupil groups (Table 52).

The relationship between left-right discrimination, as measured by the *Non-Verbal*, and visual perception as measured by the *Frostig* was much stronger in 1971 than in 1970. Both Annand and Smith reported significant positive correlations between these two tests, but there was a great increase in the number of such correlations in 1971. The correlations with the *Non-Verbal C* were particularly interesting in that pupils who scored low in copying nonsense syllables by laying magnetic letters on a metal tray also scored low in the *Frostig* subtests of: eye-motor coordination, figure-ground perception, position in space and spatial relationships and had a lower perceptual quotient as derived from the *Frostig* total.

Further evidence that the relationship between left-right discrimination as measured by the *Non-Verbal* and visual perception had strengthened between the 1970 and 1971 testings was given by the fact that Smith reported no significant differences between any *Frostig* subtest or the *Frostig* total score of pupils who were confused or discriminating on the *Non-Verbal* total one, while Annand reported significant differences in scores on several *Frostig* subtests (Table 52).

Pupils who were discriminating on the *Non-Verbal* total one scored higher on tests involving tasks of: (a) eye-motor coordination (*Frostig* I); (b) perception of geometric figures on a complex background (*Frostig* II), and (c) spatial

relations (Frostig V) in which the pupils copied designs using dots as guideposts.

Table 52

Comparisons and Summary of Relationships Between Pupils' Performance on the Benton and Non-Verbal Subtests and Total and the Frostig as Reported by Annand (1971) and Smith (1970)

Tests	Research Study Reported: Annand (1971) Significant	Level of Significance	Smith (1970) Significant	Level of Significance
Significant Correlations Between:				
Non-Verbal A and:				
Frostig I: (Eye-Motor Control)	Yes	.01	No	
Frostig II: (Figure-Ground)	Yes	.01	No	
Frostig IV: (Position in Space)	No		Yes	.01
Non-Verbal B and:				
Frostig V: (Spatial Relations)	Yes	.01	No	
Frostig total	Yes	.01	No	
Non-Verbal C and:				
Frostig I: (Eye-Motor Control)	Yes	.01	No	
Frostig IV: (Position in Space)	Yes	.01	No	
Frostig V: (Spatial Relations)	Yes	.01	Yes	.01

Table 52 (continued)

Tests	Research Study Reported: Annand (1971) Significant	Annand (1971) Level of Significance	Smith (1970) Significant	Smith (1970) Level of Significance
Non-Verbal Total One and:				
Frostig I:	Yes	.01	No	
Frostig II:	Yes	.05	Yes	.05
Frostig IV:	Yes	.05	No	
Frostig V:	Yes	.01	Yes	.01
Frostig total:	Yes	.01	No	
Non-Verbal D and:				
Frostig II:	Yes	.01		
Frostig IV:	Yes	.05		
Frostig V:	Yes	.01		
Frostig total:	Yes	.01		
Non-Verbal Total Two and:				
Frostig I:	Yes	.01		
Frostig II:	Yes	.01		
Frostig IV:	Yes	.01		
Frostig V:	Yes	.01		
Frostig total:	Yes	.01		
Significant Differences Between:				
Frostig IV scores of:				
Confused, discriminating and consistently reversing groups on the Benton A	No		Yes Consistently reversing group significantly higher than confused group	.005
Frostig I and IV scores of:				
Confused and discriminating groups on the Benton B	No		Yes Discriminating group higher	.01 and .05

Table 52 (continued)

Tests	Research Study Reported: Annand (1971) Significant	Annand (1971) Level of Significance	Smith (1970) Significant	Smith (1970) Level of Significance
Frostig I, II, V, and total scores of:				
Confused or discriminating groups on the Non-Verbal Total One	Yes	.01, .04, .002,.001 Discriminating group higher	No	
Frostig II and IV scores of:				
Confused or discriminating groups on the Non-Verbal Total Two	Yes	.03, .007		

CHAPTER VI

FINDINGS OF THE STUDY: RELATIONSHIPS BETWEEN PUPIL PERFORMANCE ON TESTS OF LATERAL DOMINANCE AND OTHER TESTS

In chapter six, the findings of the study are discussed under the following headings:

Relationship between pupil performance on:

1. Three tests of lateral dominance
2. Tests of lateral dominance and each of:
   a. Reading achievement
   b. Left-right discrimination
   c. Verbal ability
   d. Visual perception.

RELATIONSHIPS BETWEEN PUPIL PERFORMANCE ON THREE TESTS OF LATERAL DOMINANCE

In this section, the relationship between the performance of pupils on tests of lateral dominance, the:

1. Harris Tests of Lateral Dominance
2. Extensibility
3. Extensibility Two

are reported as follows:

1. Chi-square frequency
2. Comparisons

Chi-Square Frequency

There were no significant relationships between lateral dominance status as determined by the: Harris, Extensibility or Extensibility Two (Table 53). Pupils who were classified in a certain way on one of these tests were not more likely to be classed in a certain way on either of the others. For example, if a pupil were classed as consistent on the Extensibility he would be no more likely to be classed as established lateral dominant or crossed dominant on the Harris than if he were classed as inconsistent on the Extensibility.

Comparisons

Smith (1970) did not report these results so no comparisons could be made.

RELATIONSHIPS BETWEEN PUPIL PERFORMANCE ON TESTS OF LATERAL DOMINANCE AND READING ACHIEVEMENT

This section presents findings on the relationships between pupil performance on tests of lateral dominance, the:

1. Harris Tests of Lateral Dominance
2. Extensibility
3. Extensibility Two

and tests of reading, the:

1. Neale Analysis of Reading Ability
2. Gates-MacGinitie Reading Tests, Vocabulary and Comprehension, under the following headings:

Table 53

Relationship Between Dominance as Measured by the Harris, the Extensibility and the Extensibility Two

Established Lateral Dominance and Crossed Dominance:

	Established	Crossed	Total
Consistent	20	18	38
Inconsistent	6	13	19
Total	26	31	57

N=57 df=1 Chi-Square = 2.26 n.s.

Established Lateral Dominance, Crossed Dominance One, Crossed Dominance Two:

	Established	Dominance One	Dominance Two	Total
Consistent	20	4	14	38
Inconsistent	6	4	9	19
Total	26	8	23	57

df=2 Chi-Square = 2.57 n.s.

Established Lateral Dominance and Crossed Dominance:

	Established	Crossed	Total
Consistent	13	9	22
Inconsistent	4	8	12
Incomplete	9	14	23
Total	26	31	57

df=2 Chi-Square = 2.73 n.s.

Established Lateral Dominance, Crossed Dominance One, Crossed Dominance Two:

	Established	Dominance One	Dominance Two	Total
Consistent	13	2	7	22
Inconsistent	4	3	5	12
Incomplete	9	3	11	23
Total	26	8	23	57

df=4 Chi-Square = 3.63 n.s.

1. One-way analysis of variance
2. T-tests
3. Chi-square frequency
4. Comparisons and summary

   (Annand (1971) and Smith (1970)

One-Way Analysis of Variance

The mean oral reading score of the established right-handed pupils was significantly better than that of pupils who were left-handed, as calculated by the Newman-Keuls method using the studentized range distribution (Table 54). This finding concurs with Orton (1937) who reported a preponderance of left-handed children among severely retarded readers. Other researchers (Harris, 1957, and Monroe, 1932) have reported a preponderance of mixed handedness in a sample of retarded readers from a clinic population.

The mean intellectual ability score of the left-handed children, ninety-three, (Appendix I) was below the mean of the total sample which may have contributed as much as their left-handedness to their significantly lower Neale score.

There was no significant difference between the oral reading scores of the right- and incomplete-handed groups, nor between the incomplete- and left-handed groups, in the present study.

It would be interesting to investigate whether pupils who were incomplete-handed moved to being right-handed or

Table 54

One-Way Analysis of Variance Comparing Neale Scores of Groups of Pupils with Various Types of Handedness, Eyedness, Footedness on the Harris

Tests (N=57) Computations:
Summary of Analysis of Variance on Neale scores:

Source of Variance	SS	df	MS	F	P
1. Handedness					
Between Groups	1070.32	2	535.16	3.54	0.04
Within Groups	8154.56	54	151.01		

Newman-Keuls Test on Means:

	Means	2	3	1
1	18.00	32.56	25.75	18.00
2	25.75	14.56**	7.75 n.s.	
3	32.56			

Group 1: Left-handed (5 pupils)

Group 2: Right-handed (48 pupils)

Group 3: Incomplete-handed (4 pupils)

Source of Variance:	SS	df	MS	F	P
2. Eyedness					
Between Groups	277.67	1	277.67	1.71	0.19
Within Groups	8947.20	55	162.68		
3. Footedness					
Between Groups	379.41	2	189.71	1.16	0.32
Within Groups	8845.47	54	163.80		

** $p<.01$

left-handed over a period of two or more years. If the children who were incomplete-handed became right-handed the results of a more powerful statistical analysis, such as a priori statistics, might indicate a difference in cerebral organization between left-handed and right-handed children, as suggested by Zangwill (1962) and Hécaen and de Ajuriaguerra (1964).

Being left-, right- or incomplete-eyed or left-, right- or incomplete-footed had no effect upon the oral reading achievement of these pupils in the second year of school, since there was no significant difference between the mean Neale scores of these groups (Table 54).

Whether pupils had established lateral dominance or had crossed dominance of any type as measured by the Harris had no effect upon their oral and silent reading achievement as there were no significant differences in the Neale or Gates-MacGinitie scores of groups that had established lateral dominance, crossed dominance one or crossed dominance two (Table 55).

In the present study, the Extensibility Two differentiated between the performance of children who were high achievers in oral reading and that of low achievers. There was a significant difference between the Neale scores of groups of children in the second year of school that were consistent, inconsistent or incomplete on the Extensibility Two (Table 56). This finding concurred with Silver and Hagin (1960) who found that 74 percent of their reading disability

Table 55

Comparison of Neale and Gates-MacGinitie Reading Scores of Groups with Established Lateral Dominance, Crossed Dominance One, and Crossed Dominance Two

Tests (N=57)	Computations: Summary of One-Way Analysis of Variance:				
Source of Variance	SS	df	MS	F	P
Neale					
Between Groups	148.40	2	74.21	0.44	0.64
Within Groups	9076.45	54	168.08		
Gates-MacGinitie:					
Vocabulary					
Between Groups	151.43	2	75.72	1.37	0.26
Within Groups	2649.25	48	55.19		
Comprehension					
Between Groups	38.83	2	19.91	0.56	0.57
Within Groups	1698.33	48	35.38		

group had inconsistent dominance, while none of the normal reading group had inconsistent dominance.

The mean intelligence quotient of the inconsistent group, one-hundred, (Appendix I) was slightly below the mean of the total sample, so may have contributed somewhat to the their lower score.

The present researcher devised the method of marking the Extensibility Two based upon Silver and Hagin's (1960) method, aided by a translation of Hoff and Schilder's (1927) description of their arm extension test, to investigate

Table 56

Comparison of Reading Scores of Pupils Who Were Consistent, Inconsistent or Incomplete Dominant on the Extensibility Two Test

Tests	Computations: Summary of Analysis of Variance:				
Source of Variance	SS	df	MS	F	P
Neale					
Between Groups	1049.99	2	524.55	3.46	0.04
Within Groups	8175.79	54	151.40		

Newman-Keuls Test on Means:

	Means	3 30.09	1 32.96	2 22.50
2	22.50	10.59*	10.46*	
1	32.96	0.13		
3	30.09			

Group 1: Consistent dominant (22 pupils)

Group 2: Inconsistent dominant (12 pupils)

Group 3: Incomplete dominant (23 pupils)

Source of Variance:	SS	df	MS	F	P
Gates-MacGinitie:					
Vocabulary					
Between Groups	57.63	2	28.81	0.50	0.61
Within Groups	2743.06	48	57.15		
Comprehension					
Between Groups	42.93	2	21.47	0.61	0.55
Within Groups	1695.22	48	35.32		

Group 1: Consistent dominant (22 pupils)

Group 2: Inconsistent dominant (8 pupils)

Group 3: Incomplete dominant (21 pupils)

whether the Extensibility Two might effectively differentiate between the performance of children who were high in reading achievement and that of those who were low achievers.

There was no significant difference in the mean Gates-MacGinitie silent reading scores of groups of pupils in the subsample of fifty-one children that were consistent, inconsistent or incomplete on the Extensibility Two (Table 56). It should be remembered that five of the six pupils who were removed from the total sample to form the subsample because they were not administered the Gates-MacGinitie, Primary B, were among the lowest achieving readers in the total sample because they were repeating grade one. Furthermore, inspection of the data revealed that four of these five children had been in the inconsistent group in the total sample. That there was no significant difference in the mean Gates-MacGinitie scores of consistent, inconsistent or incomplete groups of children may reflect that the influence of the scores of four of the five lowest achieving readers had been removed from the inconsistent group and there were then not enough low achievers in that group to reveal a difference under statistical analysis.

T-Tests

Having established lateral dominance as measured by the Harris or lacking it had no significant effect upon the pupils' reading achievement in the second year of school since there was no significant difference between the Neale

nor Gates-MacGinitie mean scores of groups who had established lateral dominance or crossed dominance (Table 57).

Nor did lateral dominance as measured by the Extensibility have any significant effect upon the pupil's oral or silent reading achievement (Table 58).

These classifications of students as established lateral or crossed dominant do not appear to differentiate between the performance of pupils who are high or low achievers in either oral or silent reading.

Table 57

T-Tests Comparing the Reading Scores of Groups Which Had Established Lateral Dominance or Crossed Dominance

Tests	N	Means	Computations: S.D.	df	T	P
Neale (N=57)						
Established	26	31.92	12.40	55	0.60	0.55
Crossed	31	29.87	13.32			
Gates-MacGinitie: (N=51)						
Vocabulary						
Established	26	38.25	7.25	49	-0.42	0.67
Crossed	25	39.24	5.51			
Comprehension						
Established	26	26.23	5.51	49	-0.19	0.84
Crossed	25	26.56	6.38			

Table 58

T-Tests Comparing the Reading Scores of Groups Which Were Consistent or Inconsistent Dominant on the Extensibility

Tests	N	Means	Computations: S.D.	df	T	P
Neale (N=57)						
Consistent	38	32.16	12.81	55	1.13	0.26
Inconsistent	19	28.11	12.80			
Gates-MacGinitie: (N=51)						
Vocabulary						
Consistent	37	38.30	7.47	49	-0.75	0.45
Inconsistent	14	40.07	7.65			
Comprehension						
Consistent	37	26.08	5.90	49	-0.61	0.55
Inconsistent	14	27.21	6.02			

Chi-Square Frequency

Lateral Dominance and Reversals on the Neale. Left-handed children in this sample were more likely to make reversal errors in oral reading, possibly because of a tendency to move their eyes toward their dominant hand, as suggested by Dearborn's theory, or perhaps because there was some difference in their cerebral organization, as was suggested by Zangwill (1962) and Hécaen and de Ajuriaguerra (1964) regarding left-handed people.

As noted previously, the intellectual ability of the left-handed children in this sample was lower than that of

the total sample (Appendix I) which may have contributed to their making more reversal errors on the Neale.

The chi-square frequency tests showed a significant relationship at beyond the .001 level between handedness and a tendency to make reversal errors on the Neale in this sample of children (Table 59). Reading the table horizontally, 66 percent of the total children making reversal errors on the Neale were left-handed; while only 33 percent of them were right-handed. Reading vertically, 40 percent of the left-handed children made reversal errors, while only 2.08 percent of the right-handed children did so.

Pupils who had incomplete-foot dominance also tended to make reversal errors in oral reading. The chi-square frequency test showed the relationship to be significant at beyond the .05 level (Table 59). Reading horizontally, 66 percent of those making reversal errors on the Neale were incomplete-footed; 33 percent were right-footed. Reading vertically, reversal errors were made by:

1. 22 percent of the incomplete-footed pupils
2. 2.7 percent of the established right-footed pupils
3. 0 percent of the established left-footed pupils.

This may indicate a difference in cerebral organization of children who did not have established foot dominance in the second year of school. Harris (1970) reported that having incomplete-foot dominance was part of a typical pattern of lateral dominance of pupils with reading disability,

so the relationship of incomplete-footedness to reversal errors on the Neale in the present study concurs with Harris' findings.

Table 59

Relationship Between Lateral Dominance and Reversals on the Neale

Dominance	Left	Classification: Right	Incomplete	Total
Handedness:				
Non-Reversers	3	47	4	54
Percentage	(60)	(97.92)	(100)	
Reversers	2	1	0	3
Percentage	(40)	(2.08)	(0)	
Total	5	48	4	57
	df=2	Chi-Square = 13.29**		
Eyedness:				
Non-Reversers	19	33	2	54
Reversers	1	2	0	3
Total	20	35	2	57
	df=2	Chi-Square = 0.13 n.s.		
Footedness:				
Non-Reversers	4	43	7	54
Percentage	(100)	(97.73)	(77.78)	
Reversers	0	1	2	3
Percentage	(0)	(2.27)	(22.22)	
Total	4	44	9	57
	df=2	Chi-Square = 6.20*		
Established Lateral and Crossed Dominance:		Established	Crossed	Total
Non-Reversers		26	28	54
Reversers		0	3	3
Total		26	31	57
	df=2	Chi-Square = 2.66 n.s.		

Table 59 (continued)

Dominance: Established Lateral, Crossed Dominance One, Crossed Dominance Two:	Established	Classification: Dominance One	Dominance Two	Total
Non-Reversers	26	8	21	55
Reversers	0	0	2	2
Total	26	8	23	57
	df=2	Chi-Square = 3.06 n.s.		

*Significant at .05 level

**Significant at beyond .001

Intellectual level may have been a contributing factor in the low reading achievement of the incomplete-footed group, but it would seem that the difference between the mean intelligence quotient of these incomplete-footed children and that of the total sample (99.8, compared with 105, on the Lorge-Thorndike) (Appendix I) would not be enough to account for the reversal errors, so some other factor may have been operative. Harris (1970) found that incomplete-footedness was part of a typical pattern of lateral dominance characteristics in children with reading disability.

There were no other significant relationships between any other type of lateral dominance and reversals in reading.

Comparisons and Summary

There were several changes in the pattern of relationships between lateral dominance and oral reading achievement in 1970 and 1971 (Table 58), but some relationships

remained the same.

Smith (1970) found no significant differences in the oral reading scores of pupils who had established left- or right- or incomplete dominance of hand, eye, or foot (Table 60), but the present study found that established left-handed pupils scored significantly lower on the Neale than established right-handed pupils. This is a seldom reported finding in a normal school population, though several researchers using a reading clinic population have found a significant relationship between reading disability and lateral dominance characteristics (Dearborn, 1931; Monroe, 1932; Harris, 1957; Forness, 1970). Harris (1970) suggested that the reason that few such significant relationships have been reported might be that researchers using normal school populations would typically have so few children with anomalies of dominance and reading disability that no significant statistical relationship would show up in their studies.

Annand (1971) found that pupils with established left-hand dominance and incomplete-foot dominance were more likely ($p<.05$) to make reversal errors on the Neale. Since reversal errors are associated with reading disability these lateral dominance characteristics might also be associated with reading disability.

That the left-handed pupils in the present sample had a lower intelligence quotient than that of the total sample, as reported earlier, may have contributed to their lower scores on the Neale. The mean intelligence quotient of the

Table 60

Comparisons and Summary of Pupil Performance on Tests of Lateral Dominance and Reading Achievement as Reported by Annand (1971) and Smith (1970)

Tests	Research Study Reported: Annand (1971) Significant	Annand (1971) Level of Significance	Smith (1970) Significant	Smith (1970) Level of Significance
Harris handedness: Significant difference between Neale scores	Yes Left-handed children scored lower	.01	No	
Significant relation between:				
Handedness and reversal errors on the Neale:	Yes Left-handed children tended to reversal errors	.001	No	
Footedness and reversal errors' on the Neale:	Yes Incomplete-footed pupils were more likely to make reversals on the Neale	.05	No	
Established and crossed dominance and reversal errors on the Neale:	No		Yes Established lateral dominant pupils were more likely to make reversal errors on the Neale	Not given

incomplete-footed groups was slightly below that of the total sample so may have contributed somewhat to the lower score of this group of children. Smith (1970), however, reported no significant relationship between established right-, established left- or incomplete-dominance of hand, eye, or foot and reversals on the Neale.

The above relationships may have shown up in the present study because as many of the children from Smith's (1970) study as could be found were included in the present study whether they were placed in grade one or grade two. Five children out of the total sample of fifty-seven might be classed as retarded readers since they were repeating grade one. Normally they would not be included in a sample of children in the second year of school, but because this was a longitudinal-type study they were included.

The present study found a significant difference between the oral reading achievement scores of groups of children who were consistent, inconsistent or incomplete on the Extensibility Two which suggests that this test might be a useful tool to help diagnose pupils with reading disability. The Extensibility Two was based upon the present researcher's interpretation of Silver and Hagin's (1960) method, aided by a translation of Hoff and Schilder's (1927) description of their arm extension test, to investigate whether the Extensibility Two might effectively differentiate between the performance of children who were high in reading achievement and that of those who were low achievers. There was no

significant difference in the silent reading scores of these three groups, which may have reflected that in the Gates-MacGinitie subsample five of the poorest readers from the total sample had been removed and four of these five low readers had been in the inconsistent groups when the analysis of variance was performed on the Neale scores. When the influence of these lowest readers was removed there was no significant difference in the silent reading scores of the three groups.

Neither Annand nor Smith found a significant difference between the mean Neale scores of pupils who were consistent or inconsistent on the Extensibility.

Both Annand and Smith found no significant difference between the Neale scores of groups with established lateral dominance or crossed dominance, a finding which was in agreement with researchers such as Balow (1963) and Belmont and Birch (1965) who tested children from a normal school population and found no significant difference between the reading scores of children with established lateral or crossed dominance.

Smith found that pupils with established lateral dominance were more likely to make reversal errors on the Neale, but Annand found no relationship between established lateral dominance and reversal errors on the Neale.

RELATIONSHIPS BETWEEN PUPIL PERFORMANCE ON TESTS OF LATERAL DOMINANCE AND LEFT-RIGHT DISCRIMINATION

Relationships between pupil performance on tests of

lateral dominance, the:

1. Harris Tests of Lateral Dominance
2. Extensibility
3. Extensibility Two

and tests of left-right discrimination, the:

1. Benton Test of Right-Left Discrimination
2. Non-Verbal Test of Directional Orientation

are discussed in this section as follows:

1. T-tests
2. Chi-square frequency
3. Comparisons and summary

   Annand (1971) and Smith (1970)

T-Tests

In the second year of school having established lateral dominance or crossed dominance on the Harris had no significant effect upon the left-right discrimination abilities of the pupils as measured by the Benton B and C and the Non-Verbal, since the differences between the mean scores of these groups on the Benton and Non-Verbal was not significant (Table 61).

This finding concurs with Benton's hypothesis (1959, p. 141) that children with strong left- or strong right-hand preferences have a higher left-right discrimination ability on the sensorimotor level, that is, as is required to discriminate between the left and right sides of their own bodies, as measured by the Benton A, but may not perform better on the Benton B or C for which knowledge of the

Table 61

T-Tests Comparing Established Lateral and Crossed Dominant Pupils on the Benton and Non-Verbal Subtest and Total Scores

Tests (N=57)	N	Means	S.D.	df	T	P-Two-Tail
			Computations:			
Benton A						
Established	26	20.35	7.03	55	1.19	0.23
Crossed	31	17.81	8.76			
Benton B						
Established	26	1.50	1.88	55	-1.31	0.20
Crossed	31	2.16	1.92			
Benton C						
Established	26	1.04	1.54	55	-0.33	0.75
Crossed	31	1.16	1.32			
Benton Total						
Established	26	22.85	8.44	55	0.76	0.45
Crossed	31	21.03	9.39			
Non-Verbal A						
Established	26	10.00	0.00	55	1.24	0.22
Crossed	31	9.90	0.40			
Non-Verbal B						
Established	26	3.81	2.50	55	-0.27	0.79
Crossed	31	2.50	2.73			
Non-Verbal C						
Established	26	11.69	1.12	55	-0.30	0.76
Crossed	31	11.77	0.92			
Non-Verbal Total One						
Established	26	25.35	2.98	55	-0.29	0.77
Crossed	31	25.58	3.06			
Non-Verbal D						
Established	26	8.62	1.81	55	0.39	0.70
Crossed	31	8.42	1.93			
Non-Verbal Total Two						
Established	26	33.96	3.87	55	-0.04	0.97
Crossed	31	34.00	3.73			

meaning of left and right is required.

Pupils with established lateral dominance and pupils with crossed dominance have strong unilateral hand preferences, although people with crossed dominance are classed as crossed because they have this strong preference on different sides of their bodies for either hand, eye or foot. This would suggest that the finding of no significant effect of having established lateral dominance or crossed dominance upon the children's left-right discrimination regarding their own lateral body parts could have been anticipated.

Being consistent or inconsistent on the Extensibility had no significant effect upon left-right discrimination ability as measured by the Benton and Non-Verbal; there were no significant differences between the mean scores of these groups on the above tests of left-right discrimination (Table 62), although the difference approached significance on the Benton B ($p<.06$) with the inconsistent group scoring higher.

Table 62

T-Tests Comparing Consistent and Inconsistent Pupils on the Benton Subtests and Totals and Non-Verbal Sub-Tests and Totals

Tests	N	Means	Computations: S.D.	df	T	P-Two Tail
Benton A						
Consistent	38	19.68	7.53	55	0.93	0.34
Inconsistent	19	17.53	9.04			
Benton B						
Consistent	38	1.53	1.81	55	-1.90	0.06
Inconsistent	19	2.53	1.98			
Benton C						
Consistent	38	1.00	1.39	55	-0.79	0.43
Inconsistent	19	1.32	1.45			
Benton Total						
Consistent	38	22.11	8.48	55	0.29	0.77
Inconsistent	19	21.37	10.01			
Non-Verbal A						
Consistent	38	9.97	0.16	55	0.10	0.34
Inconsistent	19	9.89	0.46			
Non-Verbal B						
Consistent	38	3.39	2.37	55	-1.34	0.19
Inconsistent	19	4.37	2.99			
Non-Verbal C						
Consistent	38	11.74	0.95	55	0.00	1.00
Inconsistent	19	11.74	1.15			
Non-Verbal Total One						
Consistent	38	25.21	2.73	55	-0.94	0.35
Inconsistent	19	26.00	3.50			
Non-Verbal D						
Consistent	38	8.53	1.94	55	0.10	0.92
Inconsistent	19	8.47	1.74			
Non-Verbal Total Two						
Consistent	38	33.74	3.37	55	-0.69	0.49
Inconsistent	19	34.47	4.50			

Chi-Square Frequency

Lateral Dominance and the Benton. There was a significant relationship ($p<.01$) between handedness and left-right discrimination as measured by the Benton A (Table 63). A far greater proportion of left-handed children (60 percent) than incomplete-handed (25 percent) or right-handed children (4.17 percent) were consistently reversing on the Benton A, while a greater proportion (77 percent) of right-handed children than left-handed (20 percent) or incomplete-handed children (50 percent) were discriminating on the Benton A. This significant relationship supports Benton's (1959, p. 141) argument that children who have strong unilateral preference of body parts have a higher ability in discriminating the left and right sides of their own bodies.

Most of the left-handed children had the sensorimotor abilities necessary to consistently differentiate between the left and right sides of their bodies, even though they did not have the correct verbal labels for left and right. Most of the right-handed children, on the other hand, had a strong left-right "body gradient", a term used by Benton (1959) to mean ability to differentiate between the left and right sides of the body with or without the correct verbal labels for left and right, and also knew the meaning of the verbal labels for left and right and could consistently attach these labels to their own lateral body parts.

That left-handed children tended to be consistently reversing in left-right discrimination concerning their own

Table 63

Relationship Between Lateral Dominance and Left-Right Discrimination on the Benton A

Dominance	Left	Right	Incomplete	Total
	Classifications:			
Handedness:				
Confused	1	9	1	11
Percentage	(20)	(18.75)	(25)	
Discriminating	1	37	2	40
Percentage	(20)	(77.08	(50)	
Consistently Reversing	3	2	1	6
Percentage	(60)	(4.17)	(25)	
Total	5	48	4	57
	df=4	Chi-Square = 16.70** signif.		
Eyedness:				
Confused	4	6	1	11
Discriminating	13	26	1	40
Consistently Reversing	3	3	0	6
Total	20	35	2	57
	df=4	Chi-Square = 2.06 n.s.		
Footedness:				
Confused	1	8	2	11
Discriminating	1	33	6	40
Consistently Reversing	2	3	1	6
Total	4	44	9	57
	df=4	Chi-Square = 7.95 n.s.		

** $p<.01$

Table 63 (continued)

Established and Crossed:	Classifications: Established	Crossed	Total
Confused	3	8	11
Discriminating	21	19	20
Consistently Reversing	2	4	6
Total	26	31	57
df=2	Chi-Square = 2.62 n.s.		

Established, Dominance One, Dominance Two:

	Established	Dominance One	Dominance Two	Total
Confused	5	2	4	11
Discriminating	20	6	14	40
Consistently Reversing	1	0	5	6
Total	26	8	23	57
df=4	Chi-Square = 3.78 n.s.			

lateral body parts may indicate a difference in cerebral organization of these children, a condition which Zangwill (1962) and Hécaen and de Ajuriaguerra (1964) postulated exists in left-handed people, or of a difference in language function, as was suggested by Benton (1959) regarding left-handed people. It may also reflect the lower intellectual ability of the left-handed pupils in the sample.

The chi-square frequency revealed no other significant relationships between lateral dominance as measured by the Harris and left-right discrimination as measured by the Benton and Non-Verbal.

Being strongly left- or right-dominant or having

established lateral dominance or crossed dominance had no effect upon left-right discrimination as measured by Benton B (Table 64).

There was no relationship between being strongly left- or right-established dominant or having established lateral dominance or crossed dominance and left-right discrimination as measured by the Benton C in pupils in the second year of school (Table 65).

These findings concurred with Benton's hypothesis that being strongly left- or right-handed has a significant effect upon the child's discrimination of his own lateral body parts, which is a sensorimotor function, but has no significant effect upon the more complex left-right discrimination abilities, which require symbolic representation.

Lateral Dominance and the Non-Verbal. There was a significant relationship between lateral dominance as measured by the Harris and left-right discrimination as tested by the Non-Verbal. One hundred percent of the left-handed children were confused; 40 percent of the right-handed children were confused and 60 percent were discriminating; 50 percent of the incomplete-handed children were confused and 50 percent were discriminating. One hundred percent of the incomplete-eyed subjects were confused; 54 percent of the right-eyed children were confused and 46 percent were discriminating; 5 percent of the left-eyed children were confused and 75 percent were discriminating.

Table 64

Relationship Between Lateral Dominance and Left-Right Discrimination on the Benton B

Dominance	Left	Classifications: Right	Incomplete	Total
Handedness:				
Confused	3	29	1	33
Discriminating	2	19	3	24
Total	5	48	4	57
	df=2		Chi-Square = 1.91 n.s.	
Eyedness:				
Confused	10	21	2	33
Discriminating	10	14	0	24
Total	20	35	2	57
	df=2		Chi-Square = 2.03 n.s.	
Footedness:				
Confused	3	26	4	33
Discriminating	1	18	5	24
Total	4	44	9	57
	df=2		Chi-Square = 1.17 n.s.	

	Established	Crossed	Total
Established Lateral Dominance and Crossed Dominance:			
Confused	16	17	33
Discriminating	10	14	24
Total	26	31	57
df=1		Chi-Square = 0.27 n.s.	

Established Lateral Dominance, Crossed Dominance One, Crossed Dominance Two:	Established	Dominance One	Dominance Two	Total
Confused	16	5	12	33
Discriminating	10	3	11	24
Total	26	8	23	57
df=2		Chi-Square = 0.52 n.s.		

Table 65

Relationship Between Lateral Dominance and Left-Right Discrimination on the Benton C

Dominance	Classifications: Left	Right	Incomplete	Total
Handedness:				
Confused	4	45	4	53
Discriminating	1	3	0	4
Total	5	48	4	57
	df=2	Chi-Square = 1.64 n.s.		
Eyedness:				
Confused	22	31	0	53
Discriminating	0	4	0	4
Total	22	35	0	57
	df=1	Chi-Square = 2.70 n.s.		
Footedness:				
Confused	4	41	8	53
Discriminating	0	3	1	4
Total	4	44	9	57
	df=2	Chi-Square = 0.54 n.s.		
		Established	Crossed	Total
Established and Crossed:				
Confused		23	30	53
Discriminating		3	1	4
Total		26	31	57
	df=1	Chi-Square = 1.50 n.s.		
	Established	Dominance One	Dominance Two	Total
Established, Crossed Dominance One, Crossed Dominance Two:				
Confused	28	8	22	53
Discriminating	3	0	1	4
Total	26	8	23	57
	df=2	Chi-Square = 1.70 n.s.		

The findings indicated that left-handed children were more likely to be confused on the <u>Non-Verbal</u> total one than right- or incomplete-handed pupils. These findings might indicate that the cerebral organization of the left-handed pupils was different, a condition which Zangwill (1962) and Hécaen and de Ajuriaguerra suggested existed in left-handed people, and that this difference in cerebral organization was manifested in a lower level of ability in directional orientation. That left-handed pupils tended to be confused on the <u>Non-Verbal</u> total one might also reflect the fact that the <u>Non-Verbal</u> total one was highly correlated with intellectual ability and that the pupils who were left-handed in this sample had a mean intelligence quotient which was lower than that of the total sample (Table 66).

That the incomplete-eyed group was more likely to be confused on the <u>Non-Verbal</u> total one may have been a statistical artifact in that this group had only two pupils in it and the chi-square assumes an equal distribution of the variables being measured. A larger percentage of left-eyed than right-eyed pupils were discriminating, indicating that being left-eyed did not lead to confusion in directional orientation on the <u>Non-Verbal</u> in this sample. There was no significant difference in the <u>Neale</u> scores of left- and right-eyed children in this sample (Table 54), so being left-eyed was not a disadvantage in either of these tests.

There were no other significant relationships between any type of lateral dominance and being confused or

Table 66

Relationship Between Lateral Dominance and Left-Right Discrimination on the Non-Verbal Total One

Dominance	Classifications: Left	Right	Incomplete	Total
Handedness:				
Confused	5	19	2	26
Percentage	(100)	(39.58)	(50)	
Discriminating	0	29	2	31
Percentage	(0)	(60.42)	(50)	
Total	5	48	4	57
	df=2	Chi-Square = 6.70*		
Eyedness:				
Confused	5	19	2	26
Percentage	(25)	(54.29)	(100)	
Discriminating	15	16	0	31
Percentage	(75)	(45.71)	(0)	
Total	20	35	2	57
	df=2	Chi-Square = 6.87*		
Footedness:				
Confused	3	18	5	26
Discriminating	1	26	4	31
Total	4	44	9	57
	df=2	Chi-Square = 2.14 n.s.		

*Significant at beyond .05 level

Table 66 (continued)

Dominance:	Classifications: Established	Crossed	Total
Established and Crossed:			
Confused	13	13	26
Discriminating	13	18	31
Total	26	31	57

df=1 Chi-Square = 0.37 n.s.

	Established	Dominance One	Dominance Two	Total
Established, Crossed Dominance One, Crossed Dominance Two:				
Confused	13	4	9	26
Discriminating	13	4	14	31
Total	26	8	23	57

df=2 Chi-Square = 0.65 n.s.

discriminating in left-right discrimination as determined by the Non-Verbal (Table 66) total one or by the Non-Verbal total two (Table 67).

Mirror Reversals on the Benton and Dominance. A further analysis of the relationships between lateral dominance and left-right discrimination was made by comparing the proportion of pupils who made mirror reversals on the Benton total with the proportion who had established lateral dominance or crossed dominance. Furthermore, the crossed

Table 67

Relationship Between Lateral Dominance and Left-Right Discrimination on the *Non-Verbal* Two

Dominance	Classifications: Left	Right	Incomplete	Total
Handedness:				
Confused	4	20	2	26
Discriminating	1	28	2	31
Total	5	48	4	57
	df=2	Chi-Square = 2.72 n.s.		
Eyedness:				
Confused	6	18	2	26
Discriminating	14	17	0	31
Total	20	35	2	57
	df=2	Chi-Square = 4.82 n.s.		
Footedness:				
Confused	2	19	5	26
Discriminating	2	25	4	31
Total	4	44	9	57
	df=2	Chi-Square = 0.49 n.s.		
		Established	Crossed	Total
Established Lateral Dominance and Crossed Dominance:				
Confused		12	14	26
Discriminating		14	17	31
Total		26	31	57
	df=1	Chi-Square = 0.00 n.s.		
	Established	Dominance One	Dominance One	Total
Established Lateral Dominance, Crossed Dominance One, Crossed Dominance Two:				
Confused	12	5	9	26
Discriminating	14	3	14	31
Total	26	8	23	57
	df=2	Chi-Square = 1.31 n.s.		

dominant group was subdivided into two types of crossed dominance:

1. Crossed dominance one, which was crossed hand and foot or crossed foot and eye, and

2. Crossed dominance two, which was crossed hand and eye. The relationship between the proportion of pupils who made mirror reversals on the Benton and the proportion who had established lateral dominance or crossed dominance of any type was not significant (Table 68). T-tests and analysis of variance, reported earlier, showed no significant differences in the Benton subtest scores of pupils who had established lateral dominance or crossed dominance of any type, so the above results regarding mirror reversals on the Benton possible could have been anticipated.

Comparisons and Summary

As in the first year of school (Smith, 1970), a significant relationship between lateral dominance and left-right discrimination was found in the second year of school, but the pattern of the relationship was somewhat different (Table 69). Smith (1970) found that pupils who had established lateral dominance on the Harris scored significantly higher in left-right discrimination as measured by the Benton A and the Non-Verbal C and argued, therefore, that strongly established lateral dominance lead to better left-right discrimination which in turn lead to better reading achievement in pupils in grade one.

Table 68

Relationship Between Mirror Reversals on the Benton Total and Established Lateral Dominance and Crossed Dominance

Dominance	Classifications: Established	Crossed	Total
Established and Crossed:			
No Mirror Reversals on Benton	20	18	38
Mirror Reversals on Benton	6	13	19
Total	26	31	57
	df=1	Chi-Square = 2.26 n.s.	

	Established	Dominance One	Dominance Two	Total
Established, Crossed Dominance One, Crossed Dominance Two:				
No Mirror Reversals on Benton	20	5	13	38
Mirror Reversals on Benton	6	3	10	19
Total	26	8	23	57
	df=2	Chi-Square = 2.34 n.s.		

Table 69

Comparison and Summary of Relationships Between Pupil Performance on Tests of Lateral Dominance and Left-Right Discrimination as Reported by Annand (1971) and Smith (1970)

	Research Study Reported:			
	Annand (1971)		Smith (1970)	
Tests	Significant	Level of Significance	Significant	Level of Significance
Harris and				
Benton and Non-Verbal:				
Significant difference between Benton A scores of pupils with established lateral or crossed dominance	No		Yes Pupils with established dominance scored higher	.01
Significant difference between Non-Verbal C scores of pupils with established lateral or crossed dominance	No		Yes Pupils with established dominance scored higher	.02
Significantly more left-handed pupils were consistently reversing on the Benton A	Yes	.01	No	
Significantly more left-handed pupils were confused on the Non-Verbal total one	Yes	.05	No	

This particular relationship did not continue to exist in these pupils in the second year of school, however, as no significant difference was found between the scores on any of the <u>Benton</u> subtests or total nor on any <u>Non-Verbal</u> subtests or totals one and two of pupils who had established lateral dominance or crossed dominance as measured by the <u>Harris</u>.

There was, however, still a relationship between lateral dominance and left-right discrimination in these children in the second year of school. Annand (1971) found that a significantly greater proportion of left-handed pupils than right- or incomplete-handed pupils was consistently reversing on the <u>Benton A</u>. Although the left-handed pupils could distinguish left from right on their own bodies consistently they did not know the meaning of the verbal labels left and right. Annand (1971) found that left-handed pupils tended to be confused on the <u>Non-Verbal</u> total one, but not on the <u>Non-Verbal</u> total two. Smith (1970) found no relationship between left-handedness and being confused on the <u>Non-Verbal</u>.

Annand (1971) also found that incomplete-eyed pupils tended to be confused on the <u>Non-Verbal</u>, but this was considered to be a statistical artifact since there were only two incomplete-eyed pupils in the sample.

Smith (1970) found that left-footed individuals tended to be confused on the <u>Non-Verbal</u>, but considered this a chance effect without importance. The present researcher

might interpret this finding differently, suggesting that the lower intellectual ability of left-footed pupils might cause them to score lower on the _Non-Verbal_ since the _Non-Verbal_ was significantly correlated with intellectual ability, since the left-footed group of children in the present study had a lower mean intellectual ability, ninety-seven, (Appendix I) than the total sample. This may also have been the case with the left-footed pupils in Smith's sample which was the same as the Annand sample except for three children.

The same relationship continued to exist between consistent and inconsistent extensibility and left-right discrimination in 1971 as in 1970 since both Annand and Smith found no significant difference in any _Non-Verbal_ subtests and total scores between pupils who were consistent or inconsistent on the _Extensibility_.

RELATIONSHIPS BETWEEN PUPIL PERFORMANCE ON TESTS OF LATERAL DOMINANCE AND VERBAL ABILITY

The relationships between the performance of pupils on tests of lateral dominance, the:

1. _Harris Tests of Lateral Dominance_
2. _Extensibility_
3. _Extensibility Two_

and a test of verbal ability, the _Wechsler Intelligence Scale for Children_, vocabulary subtest, are discussed in this section under these headings:

1. One-way analysis of variance
2. T-tests

3. Comparisons and summary:

(Annand (1971) and Smith (1970)

One-Way Analysis of Variance

Pupils with crossed dominance two (crossed hand and eye) scored significantly better in verbal ability than pupils with established lateral dominance. Pupils with established lateral dominance scored significantly better than pupils with crossed dominance one (crossed foot and eye or foot and hand)(Table 70). These findings indicated that having the dominant hand on the opposite side of the body to the dominant eye was not a disadvantage in learning the meaning of words in this sample of children. The incomplete-footed group, who tended to have more reversal errors on the *Neale*, an indication of reading retardation, would have been in the crossed dominance one group, so their low scores may have made that group's score significantly lower than others.

There were no significant differences in the *WISC* vocabulary subtest scores of children who were right- or left- established dominant or incomplete-dominant in hand, eye or foot (Table 71).

T-Tests

That there were no significant differences between the *WISC* scores of pupils who had established lateral dominance or crossed dominance or who had consistent or inconsistent extensibility (Table 72), indicated that having the

Table 70

One-Way Analysis of Variance Comparing WISC Vocabulary Subtest Scores of Pupils with Established Lateral Dominance, Crossed Dominance One or Crossed Dominance Two on the Harris

Tests Source of Variance	Computations: Summary of One-Way Analysis of Variance on WISC Vocabulary Scores: SS	df	MS	F	P
Established lateral dominance, crossed dominance one or crossed dominance two:					
Between Groups	266.48	2	133.24	3.56	0.03
Within Groups	2023.38	54	37.48		

Newman-Keuls Test on Means:

		3	1	2
	Means	28.23	27.96	22.25
2	22.25	6.58*	5.71*	
1	27.96	.87		
3	28.82			

Group 1: Established lateral dominance

Group 2: Crossed dominance one

Group 3: Crossed dominance two

*Significant at the .05 level

Table 71

One-Way Analysis of Variance Comparing WISC Vocabulary Scores of Pupils with Various Hand, Eye, and Foot Lateral Dominance Characteristics

Tests (N=57) Source of Variance	Computations: Summary of One-Way Analysis of Variance on WISC Vocabulary Scores: SS	df	MS	F	P
Handedness:					
Between Groups	74.46	2	37.23	0.91	0.41
Within Groups	2215.78	54	41.03		
Eyedness:					
Between Groups	277.67	1	277.67	1.71	0.20
Within Groups	8947.21	55	162.68		
Footedness:					
Between Groups	379.41	2	189.71	1.16	0.32
Within Groups	8845.47	2	163.80		

Table 72

T-Tests Comparing WISC Scores of Pupils Who Had Crossed or Established and Consistent or Inconsistent Dominance

Tests	N	Computations: Means	S.D.	T	P
WISC Vocabulary					
Established	26	27.96	6.10	0.49	0.63
Crossed	31	27.13	6.71		
WISC Vocabulary					
Consistent	38	27.76	6.59	0.42	0.67
Inconsistent	19	27.00	6.14		

preferred body parts all on one side, or having one or more of them on opposite sides, had no effect upon the verbal ability of the pupils as measured by the WISC.

However, when the crossed dominant pupils were divided into crossed dominance one and crossed dominance two in the present study, the crossed dominance two (crossed hand and eye) group had a significantly higher mean score on the WISC than the established lateral dominance group, while the established lateral dominance group's mean WISC score was significantly higher than that of the crossed dominance one (crossed foot and eye or foot and hand) group, according to the one-way analysis of variance.

Comparisons and Summary

The pattern of relationships between lateral dominance and verbal ability as measured by Annand (1971) and Smith (1970) did not change in that both these researchers found no significant differences in the WISC scores of pupils who had established left-, established right-, or incomplete-dominance of hand, eye or foot (Table 73). Neither Smith nor Annand found a significant difference between the WISC scores of pupils with established lateral dominance or crossed dominance.

However, when the crossed dominant pupils were divided into crossed dominance one and crossed dominance two in the present study, the crossed dominance two (crossed hand and eye) group had a significantly higher mean score on the WISC than the established lateral dominance group, while the

Table 73

Comparisons and Summary of Relationships Between Pupil Performance on Tests of Lateral Dominance, Verbal Ability as Reported by Annand (1971) and Smith (1970)

Tests	Research Study Reported: Annand (1971) Significant	Annand (1971) Level of Significance	Smith (1970) Significant	Smith (1970) Level of Significance
Harris and WISC				
Significant difference between WISC scores of established lateral dominance, crossed dominance one, and crossed dominance two pupils on the Harris	Yes Crossed dominance two better than established lateral dominant group which was better than crossed dominance one group	.05	Not tested	
Significant difference between established lateral dominance and crossed dominance	No		No	
Significant difference between WISC scores of groups having established or incomplete handedness, eyedness or footedness	No		No	

established lateral dominant group's mean WISC score was significantly better than that of the crossed dominance one group. It may be that the presence of the subgroup of five retarded readers in the crossed dominance one group made that group's mean WISC score significantly lower than the other two groups.

RELATIONSHIPS BETWEEN PUPIL PERFORMANCE ON TESTS OF LATERAL DOMINANCE AND VISUAL PERCEPTION

This section presents a discussion of relationships between pupil performance on tests of lateral dominance, the:

1. Harris Tests of Lateral Dominance
2. Extensibility
3. Extensibility Two

and a test of visual perception, the Marianne Frostig Developmental Test of Visual Perception under the following headings:

1. One-way analysis of variance
2. T-tests
3. Comparisons and summary:

   Annand (1971) and Smith (1970)

One-Way Analysis of Variance

There was a significant difference between the mean scores of groups that had established left-, right- or incomplete-hand dominance with a Newman-Keuls test showing that:

1. Both the incomplete-handed group and the right-handed group scored significantly higher than the left-handed group on the Frostig II (figure-ground)

2. The incomplete-handed group scored significantly higher than the left-handed group on the *Frostig* total (Table 74), indicating that left-handed pupils had more difficulty with tests involving shifts in perception of geometric forms against increasingly complex backgrounds and with all visual-perceptual tasks on the *Frostig* than right- or incomplete-handed groups. Left-handed pupils scored significantly lower than incomplete-handed pupils on the *Frostig* total and hence would have a lower perceptual quotient.

The mean score of the left-eyed group, which included the two incomplete-eyed pupils for statistical purposes, was significantly higher than the mean score of the right-eyed group on the *Frostig* I (eye-motor coordination), indication that being left-eyed had a desirable effect upon performance on that subtest, or they may have been more intelligent. There were no other significant differences between the mean scores of left-, right- or incomplete-handed or eyed groups on the *Frostig* subtests or total.

There were no significant differences between the mean scores of left-, right-, or incomplete-footed pupils on the *Frostig* subtests or totals.

Pupils in the second year of school did not score significantly better or worse on the *Frostig* subtests and total whether they had established lateral dominance, crossed dominance one, or crossed dominance two (Table 75).

There were significant differences between the *Frostig* II (figure-ground) scores of groups that had

Table 74

One-Way Analysis of Variance Comparing *Frostig* Subtest and Total Scores of Groups with Various Hand, Eye, and Foot Lateral Dominance Characteristics

Computations: Summary of One-Way Analysis of Variance on *Frostig* Scores:

Tests Handedness: (N=57)

Source of Variance	SS	df	MS	F	P
Frostig I					
Between Groups	31.44	2	15.72	1.31	0.28
Within Groups	650.03	54	12.04		
Frostig II					
Between Groups	34.04	2	17.02	4.59	0.01
Within Groups	200.00	54	3.70		

Neuman-Keuls Test Between Ordered Means:

	3	2	1
Means	19.25	18.63	16.00
1 16.00	3.25*	2.63*	
2 18.63	.63		
3 19.25			

Group 1: Left

Group 2: Right

Group 3: Incomplete

Source of Variance:	SS	df	MS	F	P
Frostig III					
Between Groups	7.80	2	3.90	0.46	0.63
Within Groups	459.47	54	8.51		
Frostig IV					
Between Groups	0.25	2	0.31	0.25	0.78
Within Groups	27.47	54	0.51		
Frostig V					
Between Groups	0.77	2	0.39	0.56	0.57
Within Groups	37.26	54	0.69		

*Significant at .05 level

Table 74 (continued)

Tests Source of Variance:	Computations: SS	df	MS	F	P
Frostig Total					
Between Groups	211.50	2	105.75	2.54	0.08
Within Groups	2249.81	54	41.66		

Neuman-Keuls Test on Ordered Means:

		3	2	1
	Means	66.00	62.65	56.80
1	56.80	9.20*	5.85	
2	62.65	3.35		
3	66.00			

Group 1: Left

Group 2: Right

Group 3: Incomplete

Eyedness:
(N=57)

Source of Variance:	SS	df	MS	F	P
Frostig I					
Between Groups	51.47	1	51.47	4.49	0.03
Within Groups	630.00	55	11.47		

Neuman-Keuls Test Between Ordered Means:

		3	2
	Means	19.41	17.46
2	17.46	1.95*	
1	19.41		

Group 1: Left- and Incomplete-eyed

Group 2: Right-eyed

Source of Variance:	SS	df	MS	F	P
Frostig II					
Between Groups	0.41	1	0.41	0.10	0.76
Within Groups	233.63	55	4.25		

*Significant at .05 level

Table 74 (continued)

Tests Source of Variance:	SS	df	Computations: MS	F	P
Frostig III					
Between Groups	1.12	1	1.12	0.13	0.72
Within Groups	466.14	55	8.48		
Frostig IV					
Between Groups	9.33	1	0.09	0.19	0.67
Within Groups	27.63	55	0.50		
Frostig V					
Between Groups	7.64	1	0.08	0.11	0.74
Within Groups	37.96	55	0.69		
Frostig Total					
Between Groups	123.81	1	123.81	2.91	0.09
Within Groups	2337.50	55	42.50		

Footedness:
(N=57)

Source of Variance:	SS	df	MS	F	P
Frostig I					
Between Groups	5.70	2	2.85	0.23	0.79
Within Groups	675.77	54	12.51		
Frostig II					
Between Groups	12.26	2	6.13	1.49	0.23
Within Groups	221.77	54	4.11		
Frostig III					
Between Groups	.74	2	0.37	0.04	0.96
Within Groups	466.53	54	8.64		
Frostig IV					
Between Groups	8.30	2	0.04	0.08	0.92
Within Groups	27.64	54	0.51		

Table 74 (continued)

Tests Source of Variance:	Computations: SS	df	MS	F	P
Frostig V					
Between Groups	0.32	2	0.16	0.23	0.79
Within Groups	37.71	54	0.70		
Frostig Total					
Between Groups	4.38	2	2.19	0.05	0.95
Within Groups	2456.94	54	45.50		

Table 75

One-Way Analysis of Variance Comparing Frostig Subtest and Total Scores of Pupils with Established Lateral Dominance, Crossed Dominance One or Crossed Dominance Two on the Harris

Tests (N=57) Source of Variance	Computations: Summary of Analysis of Variance on Frostig Scores: SS	df	MS	F	P
Frostig I					
(Eye-Motor Coordination)					
Between Groups	47.38	2	23.69	2.02	0.14
Within Groups	634.09	54	11.74		
Frostig II					
(Figure-Ground)					
Between Groups	1.50	2	0.75	0.18	0.84
Within Groups	232.53	54	4.31		
Frostig III					
(Constancy of Shape)					
Between Groups	1.35	2	0.68	0.08	0.92
Within Groups	465.91	54	8.63		

Table 75 (continued)

Tests (N=57) Source of Variance	Computations: Summary of Analysis of Variance on Frostig Scores: SS	df	MS	F	P
Frostig IV					
(Position in Space)					
Between Groups	0.18	2	0.09	0.18	0.84
Within Groups	27.54	54	0.51		
Frostig V					
(Spatial Relationship)					
Between Groups	1.47	2	0.74	1.09	0.35
Within Groups	36.56	54	0.68		
Frostig Total					
Between Groups	58.50	2	29.25	0.66	0.52
Within Groups	2402.81	54	44.50		

consistent, inconsistent or incomplete dominance on the Extensibility Two with the Newman-Keuls Tests on Means showing that both the consistent and incomplete dominant groups significantly higher than the inconsistent dominant group (Table 76). This may indicate a difference in cerebral organization of the inconsistent dominant group, as suggested by Silver and Hagin (1960) about pupils with inconsistent dominance. They found that 74 percent of their reading disability group had inconsistent dominance on this test.

Table 76

One-Way Analysis of Variance Comparing Frostig Subtest and Total Scores of Consistent, Inconsistent and Incomplete Groups of Pupils on the Extensibility Two

Tests (N=57)	Computations: Summary of One-Way Analysis of Variance on Frostig Subtests and Total:				
Source of Variance	SS	df	MS	F	P
Frostig I					
Between Groups	30.46	2	15.23	1.26	0.29
Within Groups	651.02	54	12.06		
Frostig II					
Between Groups	28.09	2	14.04	3.68	0.03
Within Groups	205.95	54	3.81		

Newman-Keuls Test on Means:

		1	3	2
	Means	18.86	18.74	17.08
2	17.08	1.78*	1.66*	
3	18.74	0.13		
1	18.86			

Group 1: Consistent Dominant (22)

Group 2: Inconsistent Dominant (12)

Group 3: Incomplete Dominant (23)

Source of Variance:	SS	df	MS	F	P
Frostig III					
Between Groups	20.00	2	10.00	1.21	0.31
Within Groups	447.26	54	8.28		
Frostig IV					
Between Groups	1.39	2	0.69	1.43	0.25
Within Groups	26.33	54	0.49		

*Significant at .05 level

Table 76 (continued)

Source of Variance:	SS	df	MS	F	P
Frostig V					
Between Groups	2.76	2	1.38	2.11	0.13
Within Groups	35.27	54	0.65		
Frostig Total					
Between Groups	2.76	2	1.38	2.11	0.13
Within Groups	35.27	54	0.65		

T-Tests

There were no significant differences between the Frostig subtests or total scores of groups which had:

1. Crossed or established dominance on the Harris (Table 77)

2. Consistent or inconsistent extensibility on the Extensibility (Table 78) indicating that these lateral dominance characteristics had no effect upon visual perception as measured by the Frostig in this sample of pupils in the second year of school.

Comparisons and Summary

There was a change in the pattern of relationships between the pupils' 1970 and 1971 performance on tests of lateral dominance and visual perception (Table 79).

Both Smith (1970) and Annand (1971) found no significant difference in the Frostig subtests or total scores of pupils who had established left- or right- or incomplete-

Table 77

T-Tests Comparing *Frostig* Subtest and Total Scores of Established Lateral Dominant and Crossed Dominant Pupils

Tests	N	Means	S.D.	T	P
		Computations:			
Frostig I					
Established	26	17.58	3.05	-1.26	0.21
Crossed	31	18.74	3.79		
Frostig II					
Established	26	18.62	1.77	0.59	0.55
Crossed	31	18.29	2.27		
Frostig III					
Established	26	11.31	3.04	0.14	0.88
Crossed	31	11.42	2.80		
Frostig IV					
Established	26	7.35	0.85	-0.56	0.58
Crossed	31	7.45	0.57		
Frostig V					
Established	26	6.85	0.78	0.62	0.54
Crossed	31	6.71	0.86		
Frostig Total					
Established	26	61.73	6.75	-0.66	0.51
Crossed	31	62.90	6.59		

Table 78

T-Tests Comparing Frostig Subtest and Total Scores of Consistent and Inconsistent Dominant Pupils

Tests	N	Means	Computations: S.D.	T	P
Frostig I					
Consistent	38	18.32	3.19	0.32	0.75
Inconsistent	19	18.00	4.11		
Frostig II					
Consistent	38	18.71	1.78	1.43	0.15
Inconsistent	19	17.89	2.45		
Frostig III					
Consistent	38	11.50	2.70	0.48	0.63
Inconsistent	19	11.11	3.30		
Frostig IV					
Consistent	38	7.34	0.78	-0.93	0.36
Inconsistent	19	7.53	0.51		
Frostig V					
Consistent	38	6.79	0.87	0.23	0.82
Inconsistent	19	6.74	0.73		
Frostig Total					
Consistent	38	62.66	6.28	0.46	0.65
Inconsistent	19	61.79	7.43		

footedness. Smith also found no significant difference in the *Frostig* subtests or total scores of established left- or right- or incomplete-eyedness, but Annand found that the established left-eyed groups scored significantly higher than the right-eyed group on *Frostig* I (eye-motor coordination).

Smith found that the established lateral dominant group also scored significantly higher ($p<.03$) on the *Frostig* V (spatial relationships) than the crossed dominant group, but Annand found no significant difference on the established lateral dominant or crossed dominant group on any of the *Frostig* subtests.

Annand and Smith both found no significant difference between any *Frostig* subtests or total scores of consistent or inconsistent dominant groups, but the difference in the *Frostig* II (figure-ground) and *Frostig* V approached significance ($p<.07$) in Smith's study.

Annand found that consistent and incomplete dominant groups on the *Extensibility Two* scored significantly higher on the *Frostig* II (figure-ground) than did the inconsistent group ($p<.03$).

Table 79

Comparisons Between Relationships Between Pupil Performance on Tests of Lateral Dominance and Visual Perception as Reported by Annand (1971) and Smith (1970)

Tests	Research Study Reported: Annand (1971) Significant	Annand (1971) Level of Significance	Smith (1970) Significant	Smith (1970) Level of Significance
Harris and				
Frostig:				
Significant difference in Frostig I (eye-motor coordination) scores of left- and right-handed groups	Yes Left-eyed group scored higher	.03	No	
Significant difference in Frostig V (spatial relationships) scores between established left--established right- and incomplete-handed groups	No		Yes Established left- and established right- handed groups significantly higher than incomplete-handed group	.03
Significant difference in Frostig V (spatial relationships) between established lateral dominant and crossed dominant groups	No		Yes Established lateral dominant group scored significantly higher	.03

CHAPTER VII

SUMMARY, CONCLUSIONS AND IMPLICATIONS

This chapter summarizes the purpose, experimental design and results of the study and compares the findings with those of Smith (1970). Conclusions are reached, implications are drawn and suggestions for further study are offered.

SUMMARY

The problem, as expressed in the research literature, was that it was not known whether lateral dominance and left-right discrimination were significantly related to reading achievement in young children. Hence both lateral dominance and left-right discrimination were investigated in the present study.

The purpose of the present study was twofold:

1. It investigated the relationship between left-right discrimination and reading achievement, and between lateral dominance and reading achievement, in children in the second year of school. Various aspects of lateral dominance in relation to left-right discrimination were also studied. The natures of lateral dominance and left-right discrimination were examined further by comparing the visual-perceptual and verbal abilities of children classified according to whether they possessed established dominance,

incomplete dominance,established lateral dominance or crossed dominance, and according to whether they could successfully discriminate left and right.

2. It provided repeated measures data to add to Smith's (1970) so that an indication of the longitudinal development of lateral dominance and left-right discrimination, as well as the relationships of these factors to gains in reading achievement, might be ascertained. The following comparisons were also made: the lateral dominance characteristics, left-right discrimination ability, and reading achievement and verbal and visual-perceptual abilities of these children as measured by certain tests in May, 1971, were compared with the same abilities of these children as tested in May, 1970, by Smith (1970). This study in this way provided additional data on a sample of fifty-seven children in the second year of school in a large urban school system. The pupils' scores on the following tests were obtained:

1. Two tests of left-right discrimination, the:
   a. Benton Test of Right-Left Discrimination
   b. Non-Verbal Test of Directional Orientation
2. Three tests of lateral dominance, the:
   a. Harris Tests of Lateral Dominance
   b. Extensibility
   c. Extensibility Two

3. Two tests of reading ability, the:

    a. <u>Neale Analysis of Reading Ability</u>, Form A

    b. <u>Gates-MacGinitie Reading Tests</u>, Primary B, Form I

4. One test of verbal ability, the: <u>Wechsler Intelligence Scale for Children</u>, Vocabulary Subtest

5. One test of visual perception, the: <u>Marianne Frostig Developmental Test of Visual Perception</u>

6. One test of intellectual ability, the: <u>Lorge-Thorndike Intelligence Tests</u>, Level Two.

All of the tests, except the <u>Gates-MacGinitie</u>, Primary B, were administered by the present researcher in April and May, 1971. The individual tests were given in random order as determined by a table of random numbers. The group tests were administered after all of the pupils in a particular school had received the individual tests. The <u>Gates-MacGinitie</u> tests were administered in June by the classroom teachers and the scores were made available to the present researcher. The <u>Gates-MacGinitie</u> marks of only fifty-one pupils were available because five children were repeating grade one and a sixth pupil did not receive the test. The data from the above tests were analyzed using computer programs set up by the Division of Educational Research Services of the University of Alberta.

FINDINGS AND CONCLUSIONS

Null Hypothesis One

A. There is no significant correlation between total scores on the Neale and:

1. Benton subtest and total scores
2. Non-Verbal subtest and total scores

B. There is no significant difference between the Neale total scores of:

1. Confused, discriminating or consistently reversing pupils on Subtest A of the Benton
2. Confused or discriminating pupils on Subtest B of the Benton
3. Confused and discriminating pupils on Subtest C of the Benton
4. Confused and discriminating pupils on the Non-Verbal totals one and two.

C. There is no significant difference between the Benton subtest and total scores of pupils who make reversal errors on the Neale and those who do not.

D. There is no significant difference in the Non-Verbal subtest and total scores of pupils who make reversal errors on the Neale and those who do not.

A.1. This hypothesis was rejected for the Benton A and Benton total for pupils in the second year of school.

There was a significant positive correlation between the Neale and the Benton A and Benton total, at the .05 level. The correlations between the Benton B and Benton C and the Neale did not reach statistical significance.

Smith (1970) also rejected this hypothesis since he found a significant positive correlation between pupil scores on the Benton A and the Neale and a significant negative correlation between the Benton C and the Neale score.

A.2. This hypothesis was rejected for the Non-Verbal C and the Non-Verbal totals one and two; there was a significant positive correlation between the Neale score and the Non-Verbal C and Non-Verbal totals one and two at beyond the .05 level. The correlation with the Non-Verbal approached significance ($p = .08$) but the correlation between the Neale score and the Non-Verbal A and D was not significant.

Smith (1970) rejected this hypothesis for pupils in the first year of school; he reported a significant correlation between the Neale and the Non-Verbal A.

B.1. This hypothesis was rejected. Pupils who were discriminating on the Benton A scored significantly better than pupils who were confused or consistently reversing. When intellectual ability or verbal ability was covaried out, however, the difference between these groups only approached significance ($p<.08$).

Smith (1970) also rejected this hypothesis, reporting

that the mean Neale score of the discriminating group was significantly higher than that of the confused group ($p<.01$). The significant difference still existed in Smith's study even when verbal ability was covaried out ($p<.05$). Smith did not covary out intellectual ability.

B.2.3.4. These hypotheses were upheld since t-tests showed no significant differences between the mean Neale scores of confused or discriminating groups on the Benton B and C and the Non-Verbal total one and two, although the difference approached significance on the Non-Verbal total two ($p<.06$) with the discriminating groups scoring higher.

Smith (1970) also upheld these three hypotheses, finding no significant difference in the mean Neale scores of groups that were confused or discriminating on the above tests.

C. This hypothesis was rejected for the Benton B since pupils who made reversal errors in oral reading scored higher on the Benton B. This hypothesis was not rejected for the Benton A, Benton C, or Benton total.

D. This hypothesis was rejected for the Non-Verbal A since those who made reversal errors on the Neale scored very significantly lower ($p<.01$) on the Non-Verbal A. It was not rejected for the Non-Verbal B, C, D, nor totals one and two.

Smith (1970) rejected hypothesis one, section C, for pupils in the first year of school for the Benton A and B, but not for the Benton C or total. He did not reject hypothesis one, section D, since none of the Non-Verbal subtests or total scores was significantly different between pupils who made reversal errors and those who did not.

Conclusion

It is concluded that in the second year of school the ability to discriminate their own left and right body parts is important in order for children to achieve highly in oral reading.

The data showed support for the first research hypothesis that higher ability in left-right discrimination of their own lateral body parts was associated with higher reading achievement in children in the second year of school. When verbal or intellectual ability was covaried out, however, the difference only approached significance. Pupils with high verbal or high intellectual ability were able to compensate for any disadvantages in oral reading which they may have had because of their left-right discrimination ability deficits.

Therefore, it is also concluded that being able to discriminate left and right on their own bodies would be most important for pupils who had low average intellectual ability, since they could not compensate so well as brighter students for any disadvantages in oral reading achievement which may

result from directional confusion, and would be, thus, at a double disadvantage in learning to read.

Null Hypothesis Two

A. There is no significant correlation between subtest and total scores on the Marianne Frostig Developmental Test of Visual Perception and:

1. Benton subtest and total scores
2. Non-Verbal subtest and total scores

B. There is no significant difference between the Frostig subtest and total scores of:

1. Confused, discriminating and consistently reversing pupils on the Benton A
2. Confused and Discriminating pupils on the:
    a. Benton B
    b. Benton C
    c. Non-Verbal totals one and two

A.1. This hypothesis was upheld. There were no significant correlations between any Benton subtest and total scores and Frostig subtest and total scores.

Smith (1970) also did not reject this hypothesis since he found no significant correlations between Benton subtest and total scores and Frostig subtest and total scores.

A.2. This hypothesis was rejected because there were significant positive correlations between the:

1. Non-Verbal A and Frostig I and II ($p<.01$)
2. Non-Verbal B and Frostig V and total ($p<.01$)

3. Non-Verbal C and Frostig I, IV, V and total ($p < .01$)

4. Non-Verbal D and Frostig II, IV, V and total ($p < .05$)

5. Non-Verbal total one and Non-Verbal total two and Frostig I, II, IV, V and total ($p < .01$).

Smith (1970) also rejected this hypothesis; he reported significant positive correlations between the Non-Verbal A and Non-Verbal total and the Frostig II, IV, V and total at the .01 and .05 levels of significance, so correlations between the Benton and Non-Verbal and Frostig were similar in 1971 and 1970, but not so many nor so strong in 1970.

B.1.2.a.b. These hypotheses were upheld since there were no significant differences between the Frostig subtest or total scores of pupils who were confused, discriminating or consistently reversing on the Benton A, though the difference on the Frostig V approached significance ($p < .06$). There were no significant differences between the Frostig subtest and total scores of pupils who were confused or discriminating on the Benton B or Benton C.

B.2.c. This hypothesis was rejected for the Frostig I, II and V and total as there were significant differences between Frostig I, II, V and total scores of pupils who were confused or discriminating on the Non-Verbal total one ($p < .05$, $p < .01$) with the discriminating group always scoring

higher. The difference approached significance on the *Frostig* IV. There were significant differences between the *Frostig* II and V and total scores of pupils who were confused or discriminating on the *Non-Verbal* total two. The difference approached significance for the *Frostig* IV ($p<.08$).

Smith (1970) rejected hypothesis B.1. for the *Frostig* IV, and hypothesis B.2.a. for the *Frostig* I and IV. He did not reject hypothesis B.2.b. nor B.2.c.

Conclusion

The research hypothesis of a relationship between left-right discrimination and visual-perceptual ability was supported by this study. Therefore, it is concluded that left-right discrimination is related to visual-perceptual ability in the second year of school.

However, this relationship existed only between visual-perceptual ability and left-right discrimination which involved non-verbal instructions. There was no relationship between visual-perceptual abilities and left-right discrimination which required the child to perform tasks involving identification of his own lateral body parts and the body parts of a drawing of a man facing him by following oral directions.

Null Hypothesis Three

A. There is no significant correlation between scores on the vocabulary subtest of the *WISC* and:

1. *Benton* subtest and total scores

2. Non-Verbal subtest and total scores

B. There is no significant difference between scores on the vocabulary subtest of the WISC and pupils who were:

1. Confused, discriminating or consistently reversing on the Benton A

2. Confused or discriminating on the:

   a. Benton B

   b. Benton C

   c. Non-Verbal total one and total two

A.1. This hypothesis was upheld. There were no significant correlations between the WISC vocabulary subtest mean scores and the Benton subtest and total scores.

A.2. This hypothesis was rejected. There were significant positive correlations ($p<.05$) between the WISC vocabulary subtest mean score and the Non-Verbal C and Non-Verbal total two.

B.1. This hypothesis was upheld. There were no significant differences between the WISC vocabulary subtest mean scores of groups which were confused, discriminating or consistently reversing on the Benton A.

B.2.a.b.c. These hypotheses were upheld. There were no significant differences between the WISC vocabulary subtest mean scores of groups which were confused or discriminating on the Benton B, Benton C, or the Non-Verbal total one and two in children in the second year of school.

Smith (1970) rejected hypotheses A.2. and B.1. for children in the first year of school. He did not reject hypotheses A.1. and B.2.a.b.c. for children in the first year of school.

Conclusion

It is concluded that left-right discrimination is related to verbal ability in the second year of school. However, this relationship existed only with left-right discrimination which involved non-verbal instructions regarding the lateral parts of the child's own body and of drawings of a person facing him. There were no relationships between verbal ability and left-right discrimination which required the child to identify his own lateral body parts and those of a drawing of a man facing him following verbal directions.

Null Hypothesis Four

> There is no significant correlation between *Benton* total and subtest scores and *Non-Verbal* total and subtest scores.

This hypothesis is rejected. There was a significant negative correlation between pupils' scores on the *Benton C* and the *Non-Verbal C*.

Smith (1970) also rejected this hypothesis. He found significant positive correlations between *Benton* and *Non-Verbal* subtests.

Conclusion

The research hypothesis that children who score higher in left-right discrimination tests involving carrying out verbal instructions regarding their own lateral body parts and those of a man in a drawing facing them will also score higher on a test which requires them to follow non-verbal instructions regarding their own lateral body parts and those of a person in a drawing facing them was not confirmed. Therefore, it is concluded that children in the second year of school who were not confused on a verbal test of left-right discrimination did not have greater competence in non-verbal left-right discrimination than those who were confused on a verbal test of left-right discrimination.

Null Hypothesis Five

A. There is no significant difference in the Neale total scores of pupils who have crossed dominance and pupils who have established lateral dominance.

B. There is no significant difference in the Neale total scores of pupils who have incomplete dominance and pupils who have established dominance.

C. There is no significant difference in the Neale total scores of pupils who are consistent or inconsistent.

D. There is no significant difference in the proportion of subjects who have crossed dominance and who make reversal errors and the proportion of pupils who have established lateral dominance and who make

reversal errors.

E. There is no significant difference in the proportion of pupils who have incomplete dominance and make reversal errors and the proportion of pupils who have established dominance and make reversal errors.

A. This hypothesis was upheld. There was no significant difference between the mean Neale scores of pupils who had crossed dominance and pupils who had established dominance.

Smith (1970) did not reject this hypothesis, since he found no significant difference in the Neale scores of pupils with crossed or established dominance.

B. This hypothesis was rejected for handedness. There was a significant difference between the mean Neale scores of left- and right-handed children, with the right-handed children scoring higher at the .01 level. There was no significant difference between the Neale mean reading scores of incomplete- and left-handed pupils or right- and incomplete-handed pupils.

Smith (1970) did not reject this hypothesis because he found no significant differences in the Neale scores of pupils who had established left-, established right- or incomplete dominance of hand, eye, or foot.

C. This hypothesis was upheld as there was no significant difference in the Neale scores of pupils who were

consistent or inconsistent on the Extensibility.

D. This hypothesis was upheld as there was no significant difference in the proportion of established lateral dominant pupils and the proportion of crossed dominant pupils who made reversal errors on the Neale.

E. This hypothesis was rejected for handedness and footedness because there were significantly more pupils with established left-hand dominance and incomplete-footedness who made reversal errors on the Neale.

Smith (1970) did not reject sections A, B, C, and E of this hypothesis since he found no significant difference in the Neale scores of the groups in sections A, B, and C and there were no significant differences in the proportions of pupils with established dominance or incomplete dominance who made reversal errors on the Neale (Section E). He did reject section D since he found that fewer crossed dominant pupils than established dominant pupils made reversal errors on the Neale.

Conclusion

It is concluded that there was a significant relationship between oral reading achievement and lateral dominance in pupils in the second year of school, as indicated by the data in this study. Pupils who were left-handed scored significantly lower in oral reading achievement than pupils who were right- or incomplete-handed. This is a seldom reported relationship in pupils in a normal school population, though

it has been reported many times in the research literature concerning reading clinic populations.

This relationship may have been revealed by the present study because this was the second year of a longitudinal-type study and all of the pupils who could be found who were in grade one when tested by Smith (1970) were included in the present sample whether they were repeating grade one or not. There was, therefore, enough of the children with left-handedness and reading disability in the present sample to show a statistical difference in scores when compared with right- and incomplete-handed children. The difference also may have been because the mean intelligence quotient of the left-handed group was lower than the mean of the total sample.

Null Hypothesis Six

A. There is no significant difference between the test means of the established lateral dominant and crossed dominant subjects on the:

1. Benton subtests and total
2. Non-Verbal subtests and totals one and two

B. There is no significant difference between the proportion of incomplete and established right- or left-dominant pupils who are:

1. Discriminating, confused or consistently reversing on the Benton A
2. Discriminating or confused on the:
    a. Benton B

b. Benton C

c. Non-Verbal totals one and two

A.1.2. These hypotheses were upheld since there was no significant difference between the means of the Benton subtests and total nor the Non-Verbal subtests and totals one and two of pupils who had established lateral dominance or crossed dominance.

B.1. This hypothesis was rejected since there was a significantly greater proportion of established left-handed children who were confused on the Benton A.

B.2.a.b. These hypotheses were upheld because there was no significant difference in the proportion of pupils who had established or incomplete dominance of hand, eye or foot and who were confused or discriminating on the Benton B or Benton C.

B.2.c. This hypothesis was rejected for the Non-Verbal total one since there was a significantly greater proportion of left-handed and incomplete-eyed pupils who were confused on this test than there was of pupils who had other types of established or incomplete dominance. This hypothesis was not rejected for the Non-Verbal total two, as there were no significant differences in proportions of pupils with various types of lateral dominance who were confused or discriminating on the Non-Verbal total two.

Smith (1970) rejected hypotheses A.1. and A.2. since

the Benton A and Benton total and the Non-Verbal C mean scores of crossed dominant pupils in the first year of school were significantly lower than the mean scores of established dominant pupils ($p<.01$). Smith did not reject hypotheses B.1.2.a.b.c. since the chi-square was not significant for the contingency tables of discrimination on the Benton A, B, or C nor on the Non-Verbal total of pupils who had established or incomplete dominance of hand, eye or foot.

Conclusion

It is concluded that lateral dominance characteristics have an effect upon the left-right discrimination abilities, both verbal and non-verbal, of pupils in the second year of school. A significantly greater proportion of left-handed pupils than right- or incomplete-handed pupils could not discriminate consistently between the left and right sides of their own bodies. Furthermore, a greater proportion of left-handed and incomplete-eyed pupils than those with other lateral dominance characteristics were classed as confused on a test which involved following non-verbal instructions regarding their own lateral body parts and those of a drawing of a person facing them.

Null Hypothesis Seven

A. There is no significant difference in the Frostig subtest and total scores of pupils who have:

1. Crossed dominance and pupils who have established lateral dominance

2. Incomplete dominance and pupils who have established dominance
3. Consistent extensibility and pupils who have inconsistent extensibility.

A.1.3. These hypotheses were upheld since there was no significant difference between the Frostig subtest and total scores of pupils in the second year of school who had established lateral dominance or crossed dominance or who were consistent or inconsistent.

A.2. This hypothesis was rejected at the .05 level because established left-handed children scored significantly lower than established right- or incomplete-handed children on the Frostig II (figure-ground subtest) and significantly lower than the incomplete-handed group on the Frostig total. This hypothesis was also rejected for eyedness, since the left-eyed group scored significantly higher on the Frostig I (eye-motor coordination) than the right-eyed group. This hypothesis was not rejected for footedness since there were no significant differences between the mean scores of left-, right- or incomplete-footed pupils on the Frostig subtests or total.

Smith (1970) rejected hypotheses A.1.2. as he found that crossed dominant pupils in the first year of school scored significantly lower than established lateral dominant pupils on the Frostig V (spatial relationships), and that incomplete-handed pupils also scored significantly lower than

right- or left-handed pupils on the Frostig V. Smith did not reject hypothesis A.3. since he found no significant differences between the Frostig subtest and total scores of pupils who had consistent or inconsistent dominance.

Conclusion

It is concluded that there was a relationship between lateral dominance and visual perception in pupils in the second year of school. Left-handed children scored significantly lower on a test of visual perception which required them to delineate certain geometric figures on increasingly complex backgrounds than right- or incomplete-handed pupils, and significantly lower than the incomplete-handed groups on the total visual-perceptual score.

It may be that the left-handed pupils in this sample did have poorer visual perception in these areas than the other pupils, or it may be that they scored lower on these tests because their mean intelligence quotient was lower than that of the total sample.

Null Hypothesis Eight

A. There is no significant difference in the WISC vocabulary scores of pupils who have:

1. Crossed dominance and pupils who have established lateral dominance
2. Incomplete dominance and pupils who have established dominance
3. Consistent extensibility and pupils who have

inconsistent extensibility.

A.1.2.3. These hypotheses were upheld. There was no significant difference in the WISC vocabulary subtest scores of pupils in the second year of school who had crossed dominance or established lateral dominance, incomplete dominance or established dominance, or consistent or inconsistent extensibility.

However, when the crossed dominant pupils were divided into crossed dominance one and crossed dominance two in the present study, the crossed dominant two (crossed hand and eye) group had a significantly higher mean score on the WISC than the established lateral dominance group, and pupils with established lateral dominance scored significantly better than pupils with crossed dominance one (crossed hand and foot or foot and eye), so that the group of pupils with crossed dominance one, which would include the incomplete-footed group that tended to make the most reversal errors on the Neale, scored the lowest on the WISC.

Smith (1970) also did not reject these hypotheses as he found no significant differences between the WISC scores of any of these groups of pupils in the first year of school.

Conclusion

It is concluded that there is a relationship between not having established lateral dominance and verbal ability in the second year of school. Pupils with crossed dominance two (crossed hand and eye) scored significantly better in verbal ability than pupils with established lateral dominance,

while pupils with established lateral dominance scored significantly better than pupils with crossed dominance one (crossed hand and foot or crossed foot and eye).

Null Hypothesis Nine

A. There is no significant difference between pupils' scores in May of the first year of school and in May of the second year of school on the following:

1. *Neale* total score
2. *Frostig* subtest and total scores
3. *Benton* subtest and total scores
4. *Non-Verbal* subtest and total scores
5. *WISC* vocabulary subtest score

A.1.2.4.5. These hypotheses were rejected since there were significant differences between pupils' scores on the *Neale*, *Frostig* subtests and total, *Non-Verbal* subtests and total and *WISC* in May, 1970, and May, 1971.

A.3. There was no significant difference between the pupils' 1970 and 1971 *Benton* subtest and total scores, thus hypothesis A.3. was upheld.

Conclusion

There was a significant difference between the 1971 and 1970 scores of the pupils in the sample in oral reading achievement, visual-perceptual ability, non-verbal left-right discrimination, and verbal ability with the 1971 scores being higher. Therefore it is concluded that pupils in the

second year of school scored higher in oral reading, visual perception, non-verbal left-right discrimination and verbal ability than pupils in the first year of school.

Null Hypothesis Ten

A. There is no significant difference between the proportion of children in May of the second year of school and the proportion in May of the first year of school who are:

1. Established dominant
2. Established lateral dominant
3. Consistent
4. Discriminating

A.1.2.3. These hypotheses were upheld since there were no significant differences between the proportion of pupils who had established dominance or established lateral dominance or who were consistent in May, 1971, and May, 1970.

A.4. This hypothesis was rejected since there were significantly more pupils who were classed as discriminating on the Benton A in 1971 than in 1970.

Conclusion

There was a significant increase in the proportion of children who could consistently differentiate between the two sides of their bodies and who knew the correct verbal labels for left and right in 1971 as compared with 1970. Therefore, it is concluded that there was a significantly greater

proportion of pupils who were discriminating with regard to their own lateral body parts in the second year of school than in the first year of school.

IMPLICATIONS

The following implications are based upon the findings and conclusions of the present study and upon the knowledge gained by comparing the findings of Annand (1971) with those of Smith (1970).

1. The finding that in the second year, as in the first year of school, pupils who were able to consistently identify their own lateral body parts and who knew the correct verbal labels for left and right scored higher in oral reading has important implications for teachers in the primary grades:

a. The above finding implies that all children who demonstrate any left-right discrimination confusion regarding their own lateral body parts, or who do not know the correct verbal labels for left and right, should be consistently taught to:

1. Discriminate between the two sides of their own body, attaching the correct verbal labels to their right and left lateral body parts

2. Discriminate the lateral body parts of a person facing them and to attach the correct verbal labels to the right and left-lateral body parts of that person.

Suggestions for improving children's left-right discrimination ability both of their own lateral body parts and

of the lateral body parts of a person facing them may be found in Appendix J.

b. These implications become even more urgent when one considers the fact that when verbal or intellectual ability were covaried out the difference between the mean oral scores of the children who could or could not consistently distinguish the left and right sides of their own bodies only approached significance. That the more intelligent children could compensate for any disadvantages which they may have in learning to read because of deficiencies in left-right discrimination of their own body parts, whereas the less intelligent children could not, has special implications for children in the low-average range of intelligence.

This situation implies that children in the primary grades with low-average intellectual ability should be very carefully taught to discriminate between their own lateral body parts and to attach the correct verbal labels for left and right to them, and to correctly identify the lateral body parts of a person facing them. Many interesting methods of doing this may be developed by innovative teachers. A few suggestions for improving children's left-right discrimination ability both of their own lateral body parts and of a person facing them and for building a bridge between left-right discrimination ability and reading achievement may be found in Appendix J.

2. The finding that pupils in the second year of school who scored lower on copying nonsense syllables by

placing magnetic letters on a metal tray also scored low on visual-perceptual tests involving eye-motor coordination, figure-ground perception, position in space, and spatial relationships and had generally low visual-perceptual ability has an important implication for teachers in the primary grades. It implies that children in the first year of school who demonstrate any confusion in identifying letters which are easily confused, such as 'b' and 'd', 'n' and 'u', 'p' and 'q', should be given training in visual perception, especially in the areas in which they demonstrate a weakness. If their confusion persists into the second, or even the third year of school, training in visual perception should be continued. Suggestions for ways in which to train children's visual perception regarding letters and words are given in Appendix J.

3. The finding that left-handed children scored significantly lower in oral reading achievement and made more reversal errors on the Neale than right- or incomplete-handed children in the second year of school implies that special care should be taken in teaching left-handed children to read and write in the beginning of their first year of school and that this special care in the teaching of left-handed children should be followed through until at least the end of the second year of school, and longer if necessary.

Suggestions for teaching left-handed children so that they write correctly and develop the habit of a left-to-right progression of their hand in writing and their eyes in

reading are given in Appendix J.

SUGGESTIONS FOR FURTHER STUDY

The following suggestions for further research lead to findings which may help children further who have inadequacies:

1. The present longitudinal-type study found a change in the pattern of relationship between pupils' performance on tests of left-right discrimination, lateral dominance, reading achievement and verbal and visual-perceptual ability in the first and second year of school. Some seldom reported significant relationships in this sample from a normal school population, such as the relationship between left-handedness and reading disability, were noted. It is, therefore, suggested that this study be extended into subsequent years.

In this way it might be determined further whether pupils who were confused in left-right discrimination of their own body parts in grade one, and who became retarded in reading, continued to be lower in reading achievement than their original classmates who were not confused in left-right discrimination of their own body parts. It also might be determined how the lateral dominance patterns of the children in this sample change over a period of several years and whether the relationship between left-handedness and reading achievement continued to another year.

Benton (1950) suggested that a careful longitudinal study extending over a period of five to ten years might

yield valuable information about the development of left-right discrimination and other perceptual abilities in children and whether or not these abilities were important only in the early stages of learning to read.

If this longitudinal-type study were continued in subsequent years the following modifications in the design might be helpful:

a. It is suggested investigations regarding silent reading be incorporated in the design so that it may be determined if the relationship between pupils' ability to consistently discriminate their left and right lateral body parts and silent reading vocabulary achievement found in the present study continues to exist in later years.

b. It is suggested that consideration be given to the use of another type of statistical analysis of the data, should such a change in the analysis appear to be advantageous concerning findings about the abilities of the children in the sample.

c. The testing of the relationship between whether or not pupils make mirror reversals on tests of left-right discrimination, both verbal and non-verbal, and their reading achievement might be incorporated into the design of the study and continued another year.

d. Dividing the crossed dominant children into those who have crossed foot and hand or crossed foot and eye dominance (crossed dominance one) and those who have crossed hand and eye dominance (crossed dominance two) might also be

incorporated into the design of study, so that the performance of these groups on the various tests used in this study might be investigated over several years.

e. The majority of the children scored very high on some of the tests in this study. It is therefore suggested that more advanced tests of these particular abilities be used so that the children's development in these abilities may continue to be measured.

f. The <u>Extensibility Two</u> was a new test added by the present researcher. It is suggested that hypotheses concerning this test be incorporated into the design of the study, should this longitudinal-type study be continued, so that the usefulness of this test as a tool to assist in diagnosing children with reading disability might be further assessed.

2. The present longitudinal-type study found changes in the relationships among certain abilities between children in the first and second year of school and no changes among certain other abilities. Since the findings of this study had important implications for teachers of children in the primary grades regarding training children in these abilities, it is suggested that this method of longitudinal-type study of a certain sample of children be applied in other areas in the primary grades so that a pattern of development of other abilities, such as auditory discrimination, auditory memory, articulatory abilities, and various language functions, in children in the contemporary cultural milieu might be ascertained.

CONCLUDING STATEMENT

This study investigated the relationship between reading achievement and each of: left-right discrimination and lateral dominance in a sample of fifty-seven children in the second year of school. These abilities in relation to certain aspects of verbal ability and visual perception were also studied. In addition, this study provided repeated measures data to add to Smith's (1970) data so that an indication of the longitudinal development of lateral dominance and left-right discrimination and verbal and visual-perceptual ability, as well as the relationships of these factors to gains in reading achievement, might also be ascertained.

This longitudinal-type study revealed that in the second year of school there was a significant relationship between reading achievement and each of: left-right discrimination and lateral dominance. It also showed a significant relationship between left-right discrimination and lateral dominance.

It was suggested that teachers of children in the primary grades should carefully teach children who show any directional confusion regarding their own lateral body parts to consistently differentiate between their lateral body parts and attach the correct verbal labels for left and right: first, to their own bodies, and, secondly, to the lateral body parts of a person facing them.

It was also suggested that the present longitudinal-type study might be continued in subsequent years with certain modifications in design.

BIBLIOGRAPHY

BIBLIOGRAPHY

A. Books

Benton, Arthur L. Right-Left Discrimination and Finger Localization, Development and Pathology. New York: Paul B. Hoeber, Inc., Medical Book Department of Harper and Brothers, 1959.

Betts, E. A. The Prevention and Correction of Reading Difficulties. Evanston, Ill.: Row, Peterson, and Co., 1936.

Bond, G. L., and Miles A. Tinker. Reading Difficulties, Their Diagnosis and Correction. 2d ed. New York: Meredith Publishing Co., 1967.

Buros, Oscar K. (ed.). The Fourth Mental Measurements Yearbook. Highland Park, N.J.: The Gryphon Press, 1953.

________. (ed.). The Fifth Mental Measurements Yearbook. Highland Park, N.J.: The Gryphon Press, 1959.

________. (ed.). The Sixth Mental Measurements Yearbook. Highland Park, N.J.: The Gryphon Press, 1965.

Clark, Margaret M. Left-Handedness, Laterality Characteristics and Their Emotional Implications. Warwick Square, London: University of London Press Ltd., 1957.

________. Reading Difficulties in Schools. Harmondsworth, Middlesex, England: Penguin Books Inc., 1970.

Critchley, M. Developmental Dyslexia. London: Heinemann, 1964.

Crosby, R. M. N. Reading and the Dyslexic Child. London, England: Souvenir Press, 1969.

Dechant, Emerald V. Improving the Teaching of Reading. Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1964.

DeHirsch, Katrina, Jeannette J. Janske, and Wm. S. Langford. Predicting Reading Failure: A Preliminary Study. New York: Harper and Row Publishers, 1966.

Ferguson, George A. Statistical Analysis in Psychology and Education. 2d ed. Toronto: McGraw-Hill Book Company, 1966.

Harris, A. J. How to Increase Reading Ability, A Guide to Developmental and Remedial Methods. 5th ed. New York: David McKay Company, Inc., 1970.

Hécaen, Henry and Julian de Ajuriaguerra. Left-Handedness, Manual Superiority and Cerebral Dominance. Eric Pender, translator. New York: Greene and Stratton, 1964.

Helmstadter, G. C. Research Concepts in Human Behavior, Education, Psychology, Sociology. New York: Appleton-Century-Crofts, Educational Division, Meredith Corporation, 1970.

Hoff, Hans and Paul Schilder. Die Lagereflexe des Menschen, Klinische Untersuchungen über Haltungs - und Stellreflexe und Verwandte Phanome. Wien: Verlag Von Julius Springer, 1927

Keeping, E. S. Introduction to Statistical Inference. Toronto: D. Van Nostrand Company, Inc., 1962.

________, and J. F. Kenney. Mathematics of Statistics. Part One. 3d ed. New York: D. Van Nostrand Company, Inc., 1954.

Kephart, N. C. The Slow Learner in the Classroom. Columbus, Ohio: Charles E. Merril Books, Inc., 1960.

Money, John. (ed.). Reading Disability: Progress and Research Needs in Dyslexia. Baltimore: The Johns Hopkins Press, 1962.

________. (ed.). The Disabled Reader, Education of the Dyslexic Child. Baltimore: The Johns Hopkins Press, 1966.

Monroe, Marion. Children Who Cannot Read. Chicago, Ill.: The University of Chicago Press, 1932.

________, and B. Backus. Remedial Reading. Boston: Houghton Mifflin Co., 1937.

Orton, Samuel T. Reading, Writing and Speech Problems in Children. New York: Norton and Co., 1937.

Penfield, Wilder and Lamar Roberts. Speech and Brain Mechanisms. New Jersey: Princeton University Press, 1959.

Piaget, Jean. Judgment and Reasoning in the Child. London: Routledge and Kegan Paul Ltd., 1928.

Roswell, Florence and Gladys Natchez. Reading Disability, Diagnosis and Treatment. New York: Basic Books Inc., 1964.

Schilder, P. Brain and Personality; Studies in the Psychological Aspects of Cerebral Neuropathology and the Neuropsychiatric Aspects of the Motility of Schizophrenics. New York: Nervous and Mental Disease Publishing Company, 1931.

Tomatis, Alfred. Dyslexia. Ottawa, Ontario: University of Ottawa Press, 1969.

Vernon, M. D. Backwardness in Reading, A Study of Its Nature and Origin. Cambridge: University Press, 1960.

Winer, B. J. Statistical Principles in Experimental Design. Toronto: McGraw-Hill Book Company, 1962.

B. Periodicals

Balow, Irving H., and Bruce Balow. "Lateral Dominance and Reading Achievement in the Second Grade," American Educational Research Journal, I, 1964, 139-143.

________. "Lateral Dominance Characteristics and Reading Achievement in the First Grade," The Journal of Psychology, LV, 1963, 323-328.

Bannantyne, Alex D., and Penny Wichiarajote. "Hemispheric Dominance, Handedness, Mirror Imaging, and Auditory Sequencing," Exceptional Children, XXXV, 1969, 27-36.

Belmont, Lillian and Herbert G. Birch. "Lateral Dominance and Right-Left Awareness in Normal Children," Child Development, XXXIV, 1963, 257-270.

________, and ________. "Lateral Dominance, Lateral Awareness and Reading Disability," Child Development, XXXVI, 1965, 56-71.

Benton, Arthur L. "Right-Left Discrimination and Finger Localization in Defective Children," Archives of Neurology and Psychiatry, LXXIV, 1955, 583-589.

________, and Joan D. Kemble. "Right-Left Orientation and Reading Disability," Psychiatria et Neurologia, CXXXIX, 1960, 49-59.

Benton, Arthur L., and Frances L. Menefee. "Handedness and Right-Left Discrimination," Child Development, XXVIII, 2 (1957), 237-242.

Boos, Robert W. "Dominance and Control: Relation to Reading Achievement," The Journal of Educational Research, LXIII, 10 (1970), 466-470.

Capobianco, R. J. "Ocular-Manual Laterality and Reading in Adolescent Mental Retardates," American Journal of Mental Deficiency, LXX, 1966, 781-785.

Coleman, R. I., and Cynthia P. Deutsch. "Lateral Dominance and Right-Left Discrimination: A Comparison of Normal and Retarded Readers," Perceptual and Motor Skills, XIX, 1964, 43-50.

Corballis, Michael C., and Ivan L. Beale. "On Telling Left from Right," Scientific American, (March, 1971), 96-104.

Dearborn, Walter F. "Ocular and Manual Dominance in Dyslexia," Psychological Bulletin, XXVIII, 1931, 704-705.

Flescher, Irwin. "Ocular-Manual Laterality and Perceptual Rotation of Literal Symbols," Genetic Psychology Monographs, LXVI, 1962, 3-48.

Forness, S. R. "Laterality in Retarded Readers with Brain Dysfunction," Exceptional Children, (May, 1970), 684-5.

Frostig, Marianne, D. W. Lefever, and J. R. B. Whittlesey. "A Developmental Test of Visual Perception for Evaluating Normal and Neurologically Handicapped Children," Perceptual and Motor Skills, XII, 1961, 383-394.

Gesell, Arnold and Louise B. Ames. "The Development of Handedness," The Journal of Genetic Psychology, LXX, 1947, 155-175.

Goodglass, Harold and F. A. Quadfasel. "Language Laterality in Left-Handed Aphasics," Brain, LXXVII (4), 1954, 521-548.

Harris, Albert J. "Lateral Dominance, Directional Confusion and Reading Disability," The Journal of Psychology, XLIV (1957), 283-294.

Hillerich, Robert L. "Eye-Hand Dominance and Reading Achievement," American Educational Research Journal, (March, 1964), 121-126.

Koos, Eugenia M. "Manifestations of Cerebral Dominance and Reading Retardation in Primary-Grade Children," The Journal of Genetic Psychology, CIV, 1964, 155-165.

Maxwell, A. E. "A Factor Analysis of the Wechsler Intelligence Scale for Children," British Journal of Educational Psychology, XXIX, 1959, 237-241.

Silver, Archie A., and Rosa Hagin. "Specific Reading Disability: Delineation of the Syndrome and Relationship to Cerebral Dominance," Comprehensive Psychiatry, I (1960), 126-134.

Spitzer, R. L., R. Rabkin, and Y. Kramer. "The Relationship Between 'Mixed Dominance' and Reading Disabilities," Journal of Pediatrics, LIV, 1959, 76-80.

Witty, Paul A., and David Kopel. "Sinistral and Mixed Manual-Ocular Behavior in Reading Disability," The Journal of Educational Psychology, XXVII, 1936, 119-134.

Zeman, Samuel S. "A Summary of Research Concerning Laterality and Reading," Journal of the Reading Specialist,(March, 1967), 116-123.

C. Articles

Bakes, Frank P. "Speech, Language and Hearing." In Frank Falkner (Ed.) Human Development, Philadelphia, P.A.: W. B. Saunders Company, 1966.

Benton, Arthur L. "Dyslexia in Relation to Form Perception and Directional Sense." In J. Money (Ed.) Reading Disability: Progress and Research Needs in Dyslexia, Baltimore: The Johns Hopkins Press, 1962.

Eisenberg, Leon. "The Epidemiology of Reading Retardation and a Program for Preventive Intervention." In J. Money (Ed.) The Disabled Reader, Education of the Dyslexic Child, Baltimore: The Johns Hopkins Press, 1966.

Hunt, Edward E. Jr. "The Developmental Genetics of Man." In Frank Falkner (Ed.) Human Development, Philadelphia, P.A.: W. B. Saunders Company, 1966.

Kinsbourne, Marcel and Elizabeth K. Warrington. "The Developmental Gerstmann Syndrome." In J. Money (Ed.) The Disabled Reader Education of the Dyslexic Child, Baltimore: The Johns Hopkins Press, 1966.

Money, John. "On Learning and Not Learning to Read." In J. Money (Ed.) The Disabled Reader, Education of the Dyslexic Child, Baltimore: The Johns Hopkins Press, 1966.

Whitsell, Leon J. "Neurologic Aspects of Reading Disorders." In R. M. Flower, H. Goffman, L. Lawson (Eds.) A Multi-disciplinary Symposium, Philadelphia, P.A.: F. A. Davis Company, 1965.

Zangwill, O. L. "Dyslexia in Relation to Cerebral Dominance." In J. Money (Ed.) Reading Disability: Progress and Research Needs in Dyslexia, Baltimore: The Johns Hopkins Press, 1962.

D. Publications of Universities and Learned Societies

Clark, Margaret M. Teaching Left-Handed Children. Publications of The Scottish Council for Research in Education. XLIV, Warwick Square, London, England: University of London Press, 1959.

Johnston, Philip W. The Relation of Certain Anomalies of Vision and Lateral Dominance to Reading Disability. Monographs of the Society for Research in Child Development, No. 2. Washington, D.C.: Society for Research in Child Development, National Research Council, 1942.

Selzer, Chas. A. Lateral Dominance and Visual Fusion, Their Application to Difficulties in Reading, Writing, Spelling and Speech. Studies in Educational Psychology and Educational Measurement. Harvard Monographs in Education, Number 12. Cambridge: Harvard University Press, 1933.

E. Unpublished Dissertations

Hundleby, G. D. "Effectiveness of the Benton Right-Left Discrimination Test in Identifying Children with Reading Disabilities." Unpublished Master's thesis, Victoria, University of Victoria, 1969.

Smith, John W. A. "Left-Right Discrimination, Lateral Dominance and Reading Achievement in Grade One Children." Unpublished Master's thesis, Edmonton: University of Alberta, 1970.

F. Tests

Frostig, Marianne, Welty Lefevre, and John R. B. Whittlesey. Marianne Frostig Developmental Test of Visual Perception. 3d ed. Palo Alto, California: Consulting Psychologist Press, 1961.

Gates-MacGinitie Reading Tests, Primary B. Form I, Vocabulary and Comprehension, New York: Teachers College Press, 1964.

Neale, M. D. Neale Analysis of Reading Ability, Individual Record Sheet, Form A. 2d ed. Toronto: MacMillan and Company Ltd., 1966.

The Lorge-Thorndike Intelligence Tests, Level 2, Form A, Primary Battery, Boston: Houghton Mifflin Company, 1957.

WISC Record Form, New York: The Psychological Intelligence Corporation, 1949.

G. Manuals

Benton, Arthur L. Right-Left Orientation Test, Victoria Form, Manual of Instructions. Victoria: Neuropsychology Laboratory, Department of Psychology, University of Victoria, 1969.

Frostig, Marianne, Welty Lefevre and John R. B. Whittlesey. Administration and Scoring Manual for the Marianne Frostig Developmental Test of Visual Perception. Palo Alto, California: Consulting Psychologist Press, 1966.

Gates, Arthur I., and Walter H. MacGinitie. Gates-MacGinitie Reading Tests, Technical Manual. New York: Teachers College Press, Teachers College, Columbia University, 1965.

________, and ________. Gates-MacGinitie Reading Tests. Primary B, Vocabulary and Comprehension for Grade Two, Teacher's Manual. New York: Teachers College Press, Teachers College, Columbia University, 1965.

Harris, Albert J. Harris Tests of Lateral Dominance, Manual of Directions for Administration and Interpretation. 3d ed. New York: The Psychological Corporation, 1958.

Lorge, Irving and Robert L. Thorndike. The Lorge-Thorndike Intelligence Tests, Examiner's Manual. Boston: Houghton Mifflin Company, 1957.

Lorge, Irving and Robert L. Thorndike. The Lorge-Thorndike Intelligence Tests, Technical Manual, Revised Edition. Boston: Houghton Mifflin Company, 1962.

Neale, M. D. Neale Analysis of Reading Ability, Manual of Directions and Norms. 2d ed. Toronto: MacMillan and Company Ltd., 1969.

Wechsler, David. Wechsler Intelligence Scale for Children, Manual. New York: The Psychological Corporation, 1949.

H. Instructional Material

Instructo Magnetic Lower Case Manuscript Assortment, Instructo Products Co., Philadelphia, Pa. 1969.

APPENDIX A

HARRIS TESTS OF LATERAL DOMINANCE

LATERAL DOMINANCE

(From Harris)

Name ______________________________

Age ______________________________ Grade _________________

1. Throw a ball ____
2. Wind a watch ____
3. Hammer a nail ____
4. Brush teeth ____
5. Comb hair ____
6. Turn door knob ____
7. Hold eraser ____
8. Use scissors ____
9. Cut with knife ____
10. Write ____

Name _________________________ ____ Sec _____ Time _____ Hand

Name _________________________ ____ Sec _____ Time _____ Hand

Footedness:

Kicking ______________

Stamping _____________

Eyedness:

Telescope _____________

Hole _________________

APPENDIX B

THE *EXTENSIBILITY* TEST

The Extensibility Test

NAME: ______________________________

Directions: Close your eyes. Hold your arms out in front of you and spread your fingers wide apart.

Hand Held Highest: ______________________________

Preferred Hand: ______________________________

Consistent: ______________________________

Inconsistent: ______________________________

APPENDIX C

BENTON TEST OF RIGHT-LEFT DISCRIMINATION

Name ______________________ Grade ____________

Age ______________________ Handedness __________

The Benton Test of Right-Left Discrimination

Section A: (Subject's Eyes Open)

1. Show left hand ____________
2. Show right eye ____________
3. Show left ear ____________
4. Show right hand ____________
5. Touch left ear with left hand ____________
6. Touch right eye with left hand ____________
7. Touch right knee with right hand ____________
8. Touch left eye with left hand ____________
9. Touch right ear with left hand ____________
10. Touch left knee with right hand ____________
11. Touch right ear with right hand ____________
12. Touch left eye with right hand ____________

(Subject's Eyes Closed)

13. Show right hand ____________
14. Show right leg ____________
15. Show right eye ____________
16. Show left ear ____________
17. Touch right ear with right hand ____________
18. Touch left knee with right hand ____________
19. Touch right eye with left hand ____________
20. Touch left ear with left hand ____________
21. Touch left eye with right hand ____________
22. Touch left knee with left hand ____________
23. Touch right shoulder with left hand ____________
24. Touch right eye with right hand ____________

Section B:

1. Point to man's right eye ____________
2. Point to man's left leg ____________
3. Point to man's left ear ____________
4. Point to man's right hand ____________

Section C:

1. Put your right hand on man's left ear ____________
2. Put your left hand on man's left eye ____________
3. Put your left hand on man's right shoulder ____________
4. Put your right hand on man's right shoulder ____________

APPENDIX D

NON-VERBAL TEST OF DIRECTIONAL ORIENTATION

Name: ____________________ Grade: ________________

Age: ____________________

<u>Right - Left Awareness - Non-Verbal</u>

<u>Directions</u>: I want you to listen carefully and do exactly what I say.

Subtest A (Use pictures)

1. Raise your hand which is on the same side of the line as the cat. ________________
2. Raise your hand which is on the same side of the line as the dog. ________________
3. Raise your hand which is on the same side of the line as the cow. ________________
4. Raise your hand which is on the side where the girl is lying down. ________________
5. Raise your hand which is on the same side of the picture as father. ________________
6. Raise your hand which is on the same side of the picture as the dog. ________________
7. Raise your hand which is on the same side of the picture as the boy's foot. ________________
8. Raise your hand which is on the same side of the picture as the horse's head. ________________
9. Raise your hand which is on the side which shows the way the rabbit is looking. ________________
10. Raise your hand which is on the same side as the words. ________________

Subtest B

Directions: I want you to listen carefully and do exactly what I say.

E.g. Use the same hand as I am using and touch this hand of the man. (right hand to right hand)

1. Use the same hand as I am using and touch this leg of the man. (right hand to right leg) ______________
2. Use the same hand as I am using and touch this leg of the man. (right hand to left leg) ______________
3. Use ______________ using and touch this hand of the man. (left hand to left hand) ______________
4. Use ______________ using and touch this eye of the man. (left hand to right eye) ______________
5. Use ______________ using and touch this ear of the man. (right hand to left ear) ______________
6. Use ______________ using and touch this eye of the man. (left hand to left eye) ______________
7. Use ______________ using and touch this shoulder of the man. (left hand to right shoulder) ______________
8. Use ______________ using and touch this shoulder of the man. (right hand to right shoulder) ______________

Subtest C

Directions: Watch me carefully and when I have finished make this word exactly as I have done.

puq ____________	debum ____________
bap ____________	qudos ____________
peb ____________	qupez ____________
qub ____________	breqof ____________
bordis ____________	drugas ____________
daput ____________	padorz ____________

NAME: ______________________

Subtest D

Examiner sits beside the subject. Each has a picture of a woman. Examiner gives the instruction and does the action, holding for two to four seconds; subject keeps hands on lap during demonstration. When examiner removes hand, subject repeats the action.

Directions: I want you to listen carefully and then do exactly as I say.

1. Use the same hand as I am using and touch this leg of the woman.
   (right hand to left leg) ____________
2. Use . . . . and touch this leg of the woman.
   (right hand to left leg) ____________
3. Use . . . . and touch this hand of the woman.
   (left hand to left hand) ____________
4. Use . . . . and touch this eye of the woman.
   (left hand to right eye) ____________
5. Use . . . . and touch this ear of the woman.
   (right hand to left ear) ____________
6. Use . . . . and touch this eye of the woman.
   (left hand to left eye) ____________
7. Use . . . . and touch this shoulder of the woman.
   (left hand to right shoulder) ____________
8. Use . . . . and touch this shoulder of the woman.
   (right hand to right shoulder) ____________

Lay out three objects, thus: (1) bottle opener; (2) pencil: (3) spool. One set in front of examiner; one set in front of the subject.

9. Use . . . . and touch this item.
   (right hand to bottle opener) ____________
10. Use . . . . and touch this item.
   (left hand to spool) ____________

APPENDIX E

GLOSSARY OF TERMS

GLOSSARY OF TERMS

Cerebral Dominance: the cerebral hemisphere which controls the language functions

Lateral Dominance: the preferred side of the body for manual tasks

Dominant Hemisphere: the cerebral hemisphere which controls the language functions

Non-Verbal Total One: the sum of the scores on subtests A, B, and C of the *Non-Verbal*

Non-Verbal Total Two: the sum of the scores on subtests A, B, C, and D of the *Non-Verbal*

Mirror Reversals: Movements were labelled mirror reversals when the child performed the exact opposite movement to that instructed or demonstrated by the examiner on the *Benton* and *Non-Verbal*; for example, if he touched a left body part with his right hand, when he had been instructed to touch a right body part with his left hand; also called mirror reversers

Crossed Dominance One: subjects having crossed hand and foot dominance or crossed foot and eye dominance as measured by the *Harris*. That is, the dominant foot was on the opposite side to the dominant hand or to the dominant eye

Crossed Dominance Two: subjects having crossed hand and eye dominance. It could mean left-handed and right-eyed, or right-handed and left-eyed

Extensibility Two: a second method of classifying data collected on the Extensibility test. The second method was based upon the present researcher's interpretation of Silver and Hagin's (1960) description of Hoff and Schilder's (1927) arm extension test which was reported in German. A translation of the pertinent section aided the present researcher in this second interpretation of the test method as described by Silver and Hagin (1960)

Consistent Dominant: the child held his preferred hand for writing, as measured by the Harris, more than one centimeter higher than his other hand

Inconsistent Dominant: the child held his preferred hand for writing, as measured by the Harris, more than one centimeter lower than his other hand

Incomplete Dominant: there was one centimeter or less between the child's two hands

APPENDIX F

RAPPORT-GAINING QUESTIONS

NAME: ______________________________

Rapport-Gaining Questions

1. How old are you? ______________________________
2. What grade are you in? ______________________________
3. Do you like reading? ______________________________
4. Do you read very much? ______________________________

   How much? ______________________________
5. What kind of stories do you like best? ______________________________
6. Do you read books with only one story in them, or books with several stories in them? ______________________________
7. Do you have a library in your schoolroom? ______________________________
8. Does your teacher let you pick a book to read when you wish? ______________________________
9. Do you get a book to read when you have a few free minutes? ______________________________
10. Do you have books of your own at home? ______________________________

    How many? ______________________________

APPENDIX G

EXTENSIBILITY TWO

The *Extensibility Two* Test

NAME: ______________________________

Directions: Close your eyes. Hold your arms out in front of you and spread your fingers wide apart.

Height of hands:

Left hand higher: ____________________

Right hand higher: ____________________

Hands the same height

(one centimeter or less difference) ____________________

Writing Hand:

Left: ____________________

Right: ____________________

Extensibility:

Consistent: ____________________

Inconsistent: ____________________

Incomplete: ____________________

APPENDIX H

TESTS FOR HOMOGENEITY OF VARIANCE

TESTS FOR HOMOGENEITY OF VARIANCE

A. F-Tests for Homogeneity of Variance on the Following Variables of:

1. Boys and Girls Groups:

Variable:	Computations: Variance One	Variance Two	DF1	DF2	F	P-Non Directional*
Neale	213.91	126.66	25	30	1.68	0.17
WISC	36.18	46.19	25	30	1.28	0.54

2. Confused and Discriminating Groups on the Benton B:

Neale	156.59	182.74	32	23	1.17	0.68
Gates-MacGinitie:						
Vocabulary:	53.83	61.43	29	20	1.14	0.73
Comprehension:	36.59	33.86	29	20	1.08	0.87
WISC	30.28	57.30	32	23	1.89	0.10
Frostig:						
I	9.03	16.72	31	24	1.85	0.11
II	3.29	5.49	31	24	1.67	0.18
III	8.03	8.75	31	24	1.09	0.81
IV	0.45	0.57	31	24	1.28	0.51
V	0.84	0.50	31	24	1.68	0.20
Total	32.16	60.53	31	24	1.88	0.10

*P = probability. A probability of .05 or less indicates the variances are significantly different from each other. (Ferguson, 1966)

3. Confused and Discriminating Groups on the Benton C:

Variable	Variance One	Variance Two	DF1	DF2	F	P-Non Directional
Neale	164.98	204.00	52	3	1.24	0.61
Gates-MacGinitie:						
Vocabulary	55.56	78.25	46	3	1.41	0.50
Comprehension	32.54	68.33	46	3	2.10	0.23
WISC	37.83	106.92	52	3	2.83	0.10
Frostig:						
I	11.64	23.33	52	3	2.01	0.25
II	3.83	8.67	52	3	2.26	0.18
III	8.52	7.00	52	3	1.22	1.02
IV	0.40	2.00	52	3	4.95	0.01
V	0.66	0.92	52	3	1.40	0.51
Total	37.59	138.25	52	3	3.68	0.04

Computations:

4. Confused and Discriminating Groups on the Non-Verbal Total One:

Variable	Variance One	Variance Two	DF1	DF2	F	P-Non Directional
Neale	198.00	131.60	25	30	1.51	0.28
Gates-MacGinite:						
Vocabulary	83.06	25.48	22	27	3.26	0.00
Comprehension	47.17	17.69	22	27	2.67	0.02
WISC	48.59	35.23	25	30	1.38	0.40
Frostig:						
I	10.79	11.67	25	30	1.08	0.85
II	5.26	2.86	25	30	1.84	0.11
III	8.07	8.53	25	30	1.06	0.90
IV	0.58	0.39	25	30	1.50	0.29
V	0.97	0.26	25	30	3.71	0.00
Total	51.54	25.63	25	30	2.01	0.07

5. Confused and Discriminating Groups on the Non-Verbal Total Two:

Variable	Variance One	Variance Two	DF1	DF2	F	P-Non Directional
		Computations:				
Neale	195.42	127.60	24	31	1.53	0.26
Gates-MacGinitie:						
Vocabulary	76.61	25.97	21	28	2.95	0.00
Comprehension	45.11	19.09	21	28	2.36	0.03
WISC	43.44	36.43	24	31	1.19	0.64
Frostig:						
I	11.77	11.82	25	30	1.01	1.00
II	5.12	2.90	25	30	1.77	0.14
III	8.60	8.24	25	30	1.04	0.90
IV	0.58	0.39	25	30	1.50	0.29
V	0.97	0.26	25	30	3.71	0.00
Total	55.10	25.99	25	30	2.12	0.05

6. No Reversal Errors and Reversal Errors on the Neale Groups:

Benton: A	60.68	192.00	53	2	3.16	0.10
Total	77.10	192.00	53	2	2.50	0.19
Non-Verbal:						
A	0.02	1.33	53	2	72.00	0.00
B	6.79	9.33	53	2	1.38	0.52
Total One	9.31	5.33	53	2	1.75	0.87
D	3.61	1.00	53	2	3.61	0.48
Total Two	14.69	6.33	53	2	2.32	0.70

7. No Mirror Reversal and Mirror Reversal Groups on the Benton:

Variable	Variance One	Variance Two	Computations: DF1	DF2	F	P-Non Directional
Neale	192.13	67.03	37	18	2.87	0.02
Gates-MacGinitie:						
Vocabulary	58.32	52.84	36	13	1.10	0.89
Comprehension	37.53	29.76	36	13	1.26	0.67
WISC	45.89	31.04	37	18	1.48	0.38

8. No Mirror Reversal and Mirror Reversal Groups on the Non-Verbal Total One and Their Scores on the:

Neale	128.05	183.79	21	34	1.44	0.39
Gates-MacGinitie:						
Vocabulary	39.31	66.69	20	29	1.70	0.22
Comprehension	25.25	41.32	20	29	1.64	0.26
WISC	29.60	48.05	21	34	1.62	0.24

9. Established Lateral Dominant and Crossed Dominant Groups:

Variable	Variance One	Variance Two	DF1	DF2	F	P-Non Directional
		Computations:				
Benton: A:	49.44	76.69	25	30	1.55	0.27
B	3.54	3.67	25	30	1.04	0.93
C	2.36	1.74	25	30	1.36	0.42
Total	71.26	88.17	25	30	1.24	0.59
Non-Verbal: B	6.25	7.43	25	30	1.19	0.66
C	1.26	0.85	25	30	1.49	0.30
Total One	8.88	9.38	25	30	1.06	0.89
D	3.29	3.72	25	30	1.13	0.76
Total Two	15.00	13.93	25	30	1.08	0.84
Neale	153.75	177.38	25	30	1.15	0.72
Gates-MacGinitie:						
Vocabulary	52.56	61.52	25	24	1.17	0.70
Comprehension	30.34	40.76	25	24	1.34	0.47
WISC:						
Vocabulary Sub-Test	37.24	44.98	25	30	1.21	0.63
Frostig:						
I	9.29	14.33	25	30	1.54	0.27
II	3.13	5.15	25	30	1.65	0.21
III	9.26	7.85	25	30	1.18	0.66
IV	0.72	0.32	25	30	2.22	0.04
V	0.62	0.75	25	30	1.21	0.63
Total	45.56	43.42	25	30	1.05	0.89

10. Consistent and Inconsistent Groups on the Extensibility:

Variable	Variance One	Variance Two	DF1	DF2	F	P-Non Directional
		Computations:				
Benton: A	56.71	81.71	37	18	1.44	0.34
B	3.28	3.93	37	18	1.20	0.62
C	1.95	2.12	37	18	1.09	0.80
Total	71.93	100.25	37	18	1.39	0.38
Non-Verbal: A	0.03	0.21	37	18	8.00	0.00
B	5.60	8.91	37	18	1.59	0.23
C	0.90	1.32	37	18	1.46	0.32
Total One	7.47	12.22	37	18	1.64	0.20
D	3.77	3.04	37	18	1.24	0.62
Total Two	11.39	20.26	37	18	1.78	0.14
Neale	164.03	163.77	37	18	1.00	1.03
Gates-MacGinitie:						
Vocabulary	55.77	58.53	36	13	1.05	0.86
Comprehension	34.85	36.18	36	13	1.04	0.88
WISC Vocabulary Subtest	43.37	37.67	37	18	1.15	0.77
Frostig:						
I	10.17	16.89	37	18	1.66	0.19
II	3.18	5.99	37	18	1.88	0.10
III	7.28	10.88	37	18	1.49	0.30
IV	0.61	0.26	37	18	2.32	0.06
V	0.77	0.54	37	18	1.42	0.43
Total	39.42	55.18	37	18	1.40	0.38

B. Chi-Square Tests for Homogeneity of Variance on the Following Variables Between:

1. Confused, Discriminating and Consistently Reversing Groups on the Benton A:

Variable	Computations: Chi-Square	Probability
Neale	3.68	0.16
Gates-MacGinitie:		
Vocabulary	3.06	0.21
Comprehension	0.52	0.77
WISC, Vocabulary Subtest	0.27	0.87
Frostig:		
I	0.36	0.84
II	0.89	0.64
III	0.07	0.97
IV	0.94	0.63
V	14.03	0.00
Total	0.42	0.81

2. Established Left-, Established Right-, and Incomplete-Handed Groups on the Harris

Neale	2.08	0.35
WISC, Vocabulary Subtest	0.20	0.91
Frostig:		
I	0.76	0.68
II	1.85	0.40
III	3.06	0.22
IV	1.51	0.47
V	1.08	0.58
Total	4.16	0.13

3. Established Left-, Established Right- and Incomplete-Eyed Groups on the *Harris*:

Variable	Computations: Chi-Square	Probability
Neale	2.21	0.64
WISC Vocabulary Subtest	0.24	0.63
Frostig:		
I	1.30	0.25
II	0.53	0.46
III	0.33	0.57
IV	1.60	0.21
V	0.59	0.44
Total	0.19	0.66

4. Established Left-, Established Right- and Incomplete-Footed Groups on the *Harris*:

Neale	0.03	0.98
WISC Vocabulary Subtest	1.75	0.42
Frostig:		
I	0.06	0.97
II	0.38	0.83
III	1.12	0.57
IV	2.00	0.37
V	4.54	0.10
Total	1.16	0.56

5. Established Lateral Dominant, Crossed Dominant One and Crossed Dominant Two Groups on the *Harris*:

Neale	1.48	0.48
Gates-MacGinitie:		
Vocabulary	0.94	0.63
Comprehension	0.73	0.69
WISC Vocabulary Subtest	0.39	0.82

5. (continued)

Variable	Computations: Chi-Square	Probability
Frostig:		
I	1.02	0.60
II	1.79	0.41
III	0.13	0.94
IV	5.62	0.06
V	10.19	0.01
Total	1.01	0.60

6. Consistent Dominant, Inconsistent Dominant and Incomplete Dominant Groups on the Extensibility Two:

Neale	2.23	0.33
Gates-MacGinitie:		
Vocabulary	2.30	0.32
Comprehension	2.02	0.36
WISC Vocabulary Subtest	1.10	0.58
Frostig:		
I	3.01	0.22
II	6.51	0.04
III	0.41	0.81
IV	2.48	0.29
V	10.95	0.00
Total	1.89	0.39

C. T-Tests for Homogeneity of Variance on the Following Variables Between 1971 and 1970 Groups:

Variables	DF	Computations: T-Test Values for Variances	P
Neale	55	5.36	0.00
WISC, Vocabulary Subtest	55	2.11	0.04
Benton:			
A	55	-0.20	0.84
B	55	0.80	0.43
C	55	1.83	0.07
Total	55	0.32	0.75
Non-Verbal:			
A	55	-5.96	0.00
B	55	-0.40	0.69
C		0.27	0.74
Total One:	55	-0.36	0.72
Frostig:			
I	55	-1.18	0.24
II	55	-3.46	0.00
III	55	-2.15	0.04
IV	55	-5.37	0.00
V	55	-3.20	0.00
Total	55	-3.28	0.00

APPENDIX I

SCORES AND CLASSIFICATIONS OF PUPILS ON VARIOUS TESTS

LEGEND

1: Pupil ID numbers

2: Sex of pupils (1: girl; 2: boy)

3: Age in months

Scores on:

4: Lorge-Thorndike

5: Neale

6: WISC

7: Benton A

8: Benton B

9: Benton C

10: Benton total

11: Non-Verbal A

12: Non-Verbal B

13: Non-Verbal C

14: Non-Verbal total one

15: Non-Verbal D

16: Non-Verbal total

17: Frostig I

18: Frostig II

19: Frostig III

20: Frostig IV

21: Frostig V

22: Frostig total

23: Pupil ID numbers

24: Writing hand (1: left hand; 2: right hand)

LEGEND (continued)

25: Dominant hand (1: left; 2: right; 3: incomplete)

26: Dominant eye (1: left; 2: right; 3: incomplete)

27: Dominant foot (1: left; 2: right, 3: incomplete)

28: Type of lateral dominance (1: established lateral dominance; 2: crossed dominance one; 3: crossed dominance two)

29: Type of lateral dominance (1: established lateral dominance; 2: crossed dominance)

30: Classification on the Benton A (1: confused; 2: discriminating; 3: consistently reversing)

31: Classification on the Benton B (1: confused; 2: discriminating)

32: Classification on the Benton C (1: confused; 2: discriminating)

33: Mirror reversals on the Benton (1: no mirror reversals; 2: mirror reversals)

34: Classification on the Non-Verbal total one (1: confused; 2: discriminating)

35: Classification on the Non-Verbal total two (1: confused; 2: discriminating)

36: Mirror reversals on the Non-Verbal (1: no mirror reversals; 2: mirror reversals)

37: Reversal errors on the Neale (1: no reversal errors; 2: reveral errors)

Scores on:

38: Gates-MacGinitie, Primary A, vocabulary subtest in 1970

LEGEND (continued)

Scores on:

39: <u>Gates-MacGinitie</u>, Primary A, comprehension subtest in 1970

40: <u>Gates-MacGinitie</u>, Primary B, vocabulary subtest in 1971

41: <u>Gates-MacGinitie</u>, Primary B, comprehension subtest in 1971

42: Classification on the <u>Extensibility Two</u> (1: consistent dominant; 2: inconsistent dominant; 3: incomplete dominant)

43: Classification on the <u>Extensibility</u> (1; consistent extensibility; 2: inconsistent extensibility)

Scores and Classifications of Pupils on Various Tests

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	1	98	109	23	28	10	0	1	11	10	0	12	22	10	32	16	18	7	8	7	56
2	1	92	92	14	24	24	0	0	24	9	2	11	22	10	32	22	19	10	7	6	64
3	1	98	101	21	23	22	4	0	26	10	0	12	22	9	31	20	20	11	6	7	64
4	1	96	86	21	16	23	0	0	23	10	5	12	32	6	33	15	17	10	8	7	57
5	1	97	101	26	27	23	0	0	23	10	4	12	28	10	38	19	19	7	8	7	60
6	1	91	108	42	27	24	4	0	28	10	5	12	27	10	37	22	19	11	7	7	66
7	1	99	99	28	18	10	0	0	10	10	6	12	28	10	38	18	20	11	8	8	65
8	1	96	99	38	40	24	0	2	26	10	0	12	22	9	31	24	20	11	8	7	70
9	1	88	114	28	33	20	4	2	26	10	4	12	26	9	35	22	18	8	8	7	63
10	1	92	108	25	34	15	3	2	20	10	4	12	26	10	36	21	19	10	8	7	65
11	2	98	129	48	42	23	4	1	27	10	2	12	24	10	34	15	20	11	8	7	61
12	2	94	108	23	23	23	0	1	24	10	8	12	30	10	40	19	20	10	8	7	64
13	2	95	112	26	31	24	4	3	31	10	8	12	30	10	40	22	20	9	8	8	67
14	2	88	107	23	29	23	0	0	23	10	4	12	26	9	35	19	20	6	6	6	57
15	2	97	103	31	27	22	0	0	22	10	8	12	30	10	40	19	18	9	8	7	61
16	2	91	108	35	26	24	0	0	24	10	1	12	23	10	33	17	20	9	8	7	61
17	2	93	123	43	35	23	0	0	23	10	6	12	28	10	38	20	20	12	7	7	66
18	2	99	95	22	26	24	4	3	31	10	2	12	24	10	34	18	19	11	8	6	62
19	2	91	90	16	19	16	0	0	16	10	1	12	23	6	29	20	14	10	8	5	57
20	2	97	105	15	25	24	4	1	29	8	7	12	27	10	37	7	11	9	7	7	51
21	1	110	87	16	23	6	3	0	9	10	0	11	22	4	26	14	14	13	6	3	50
22	1	93	138	38	38	24	0	0	24	10	7	12	29	8	37	17	19	14	8	7	65
23	1	96	103	59	27	24	4	3	31	10	4	12	26	9	35	18	19	15	7	7	66
24	1	94	102	26	33	0	4	0	4	10	0	12	22	10	32	21	20	15	8	7	71
25	1	97	117	44	30	24	4	3	31	10	8	12	30	10	40	24	20	17	8	7	76
26	1	89	89	10	20	0	4	1	5	10	1	12	23	9	32	14	19	14	7	7	61
27	1	95	87	14	20	22	4	3	29	10	0	7	17	6	23	13	14	5	7	5	44
28	2	107	85	16	21	19	0	2	21	10	2	12	24	5	29	13	16	11	7	7	54
29	2	91	82	23	19	22	4	4	30	10	3	9	22	4	26	10	15	9	5	5	44
30	2	90	89	19	24	0	0	0	0	10	3	12	25	7	32	18	16	8	7	7	56
31	2	101	89	23	14	20	4	3	27	10	1	7	18	10	28	15	20	12	7	6	60
32	2	92	122	29	26	0	1	0	1	10	4	12	26	8	34	13	19	16	8	8	64
33	2	95	104	35	34	20	0	0	20	10	5	12	27	6	33	15	19	13	8	7	62
34	2	91	104	23	17	23	4	4	31	10	5	12	27	10	37	21	20	14	8	7	71
35	2	109	106	51	32	23	0	1	24	10	7	12	29	8	37	24	20	14	8	7	73
36	2	92	110	37	25	24	0	0	24	10	0	12	23	10	33	19	20	15	7	7	68
37	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
38	2	92	98	19	26	24	0	0	24	10	1	12	23	10	33	16	15	16	7	7	61
39	2	90	113	45	40	24	4	3	28	10	7	12	29	7	36	21	18	16	7	7	69
40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
41	2	91	117	30	35	0	4	0	4	10	8	12	30	10	40	17	19	12	7	8	63
42	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
43	2	97	97	26	27	24	0	0	24	10	4	12	26	5	31	21	19	10	7	6	63
44	2	92	98	17	33	22	4	4	30	10	1	12	23	5	28	19	14	8	7	6	53
45	2	93	100	49	38	24	4	4	32	10	2	12	24	9	33	18	19	11	8	7	63
46	2	90	104	29	31	23	4	3	30	10	7	12	29	9	38	19	18	16	8	7	68
47	2	88	123	49	30	23	3	2	28	10	2	12	24	10	34	21	20	12	7	7	67
48	2	94	129	45	30	7	0	0	7	10	4	12	26	5	31	22	20	15	8	7	72
49	2	88	118	30	23	22	0	0	22	10	6	12	28	8	36	19	20	8	8	7	62
50	2	89	92	15	17	22	4	1	27	10	6	12	28	6	34	21	19	9	7	7	63
51	1	88	128	52	36	23	1	0	24	10	2	12	24	10	34	20	20	16	8	7	71
52	1	93	118	60	33	24	0	0	24	10	3	12	25	8	33	14	18	11	7	7	57
53	1	92	100	28	25	1	2	0	3	10	2	12	24	10	34	15	17	11	7	7	57
54	1	96	105	40	27	24	1	0	25	10	2	12	24	10	34	15	19	11	8	7	60
55	1	92	106	55	31	24	0	1	25	10	7	12	29	9	38	21	20	13	7	6	67
56	1	91	117	52	27	24	4	1	29	10	5	12	27	8	35	21	20	13	7	7	68
57	1	97	110	31	25	23	4	4	31	10	6	12	28	10	38	20	19	14	8	7	68
58	1	98	108	25	27	23	0	0	23	10	6	12	28	9	37	16	18	11	6	8	59
59	1	89	109	18	24	4	0	0	4	10	0	12	22	9	31	17	18	6	7	6	54
60	2	89	103	30	27	24	0	0	24	10	4	12	26	6	32	21	20	12	8	7	68

Scores and Classifications of Pupils on Various Tests

23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
1	2	2	2	2	1	1	1	1	1	2	1	1	2	1	35	25	33	21	1	1
2	2	2	2	2	3	2	2	1	1	1	1	1	2	1	19	18	21	13	3	1
3	2	2	2	2	1	1	2	2	1	1	1	1	2	1	38	25	37	27	1	1
4	2	2	2	2	2	2	2	1	1	1	2	1	2	1	36	30	34	24	1	1
5	2	2	1	2	3	2	2	1	1	2	2	2	2	1	-	-	36	21	3	1
6	2	2	1	2	3	2	2	2	1	1	2	2	2	1	47	33	42	33	3	2
7	2	2	2	2	1	1	1	1	1	2	2	2	1	1	33	26	25	20	1	1
8	2	2	1	3	3	2	2	1	1	1	1	1	2	1	46	33	47	32	1	1
9	2	2	1	2	3	2	1	2	1	2	2	2	1	1	46	31	45	31	2	2
10	2	2	1	2	3	2	1	1	1	2	2	2	2	1	43	33	45	33	1	1
11	2	2	2	2	1	1	2	2	1	1	1	2	2	1	47	32	47	32	1	1
12	2	2	1	2	3	2	2	1	1	1	2	2	1	1	44	30	39	28	1	1
13	2	2	2	2	1	1	2	2	1	1	2	2	1	1	41	26	45	32	1	1
14	2	2	2	2	1	1	2	1	1	1	2	2	2	1	36	23	36	25	3	1
15	2	2	2	2	1	1	2	1	1	2	2	2	1	1	42	23	39	29	2	2
16	2	2	3	2	2	2	2	1	1	1	1	1	2	1	39	32	42	31	3	1
17	2	2	2	2	1	1	2	1	1	1	2	2	1	1	41	30	43	33	3	1
18	2	2	2	2	1	1	2	2	1	1	1	2	1	1	26	17	33	22	1	1
19	1	1	2	1	3	2	1	1	1	1	1	1	2	1	27	7	27	14	2	2
20	2	2	1	2	3	2	2	2	1	1	2	2	1	2	29	15	-	-	2	2
21	2	2	3	2	2	2	1	1	1	2	1	1	2	1	25	15	22	18	3	1
22	2	2	1	2	3	2	2	1	1	1	2	2	2	1	-	-	44	33	1	1
23	2	2	1	2	3	2	2	2	1	1	2	1	2	1	47	34	46	33	1	1
24	2	3	1	2	3	2	3	2	1	2	1	1	2	1	41	29	40	30	1	2
25	1	3	1	1	2	2	2	2	1	1	2	2	1	1	46	32	41	24	1	2
26	1	1	2	3	3	2	3	2	1	2	1	1	2	2	24	13	-	-	2	2
27	2	2	2	2	1	1	2	2	1	1	1	1	2	1	22	12	20	16	2	2
28	2	2	2	3	2	2	1	1	1	2	1	1	2	1	22	12	-	-	2	2
29	2	2	2	2	1	1	2	2	2	1	1	1	1	1	2	9	25	14	3	1
30	1	1	1	1	1	1	3	1	1	2	1	1	2	1	23	12	35	18	1	1
31	2	2	2	3	2	2	1	2	1	1	1	1	2	1	24	15	23	17	3	1
32	2	2	2	2	1	1	3	1	1	2	2	2	1	1	45	20	44	31	3	1
33	2	2	2	2	1	1	1	2	1	2	2	1	1	1	36	23	39	26	2	2
34	2	2	2	2	1	1	2	2	2	1	2	2	2	1	38	19	38	27	3	1
35	2	2	1	2	3	2	2	1	1	1	2	2	1	1	44	34	47	34	3	1
36	2	2	2	2	1	1	2	1	1	1	1	1	2	1	36	21	36	27	1	1
37	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
38	2	2	2	2	1	1	2	1	1	1	1	1	2	1	36	21	43	26	1	1
39	2	2	1	2	3	2	2	2	1	1	2	2	1	1	46	22	45	30	1	1
40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
41	2	2	1	2	3	2	3	2	1	2	2	2	1	1	40	25	46	30	3	2
42	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
43	2	2	2	2	1	1	2	1	1	1	2	1	2	1	43	24	36	24	1	1
44	1	1	2	3	3	2	2	2	2	1	1	1	2	1	42	22	40	20	3	1
45	2	2	2	2	1	1	2	2	2	1	1	1	2	1	46	30	46	33	3	2
46	2	2	2	2	1	1	2	2	1	1	2	2	1	1	44	27	42	24	2	2
47	2	2	1	2	3	2	2	1	1	1	1	2	2	1	47	21	41	21	3	1
48	2	2	1	2	3	2	1	1	1	2	2	1	2	1	47	28	-	-	3	1
49	2	2	2	3	2	2	2	1	1	2	2	2	1	1	43	24	42	31	2	2
50	2	3	1	3	3	2	2	2	1	2	2	2	2	1	-	-	-	-	2	2
51	2	2	2	2	1	1	2	1	1	1	1	2	2	1	46	33	48	32	1	1
52	2	2	2	2	1	1	2	1	1	1	1	1	1	1	48	33	46	32	1	1
53	1	1	2	1	3	2	3	1	1	2	1	2	2	1	44	28	40	29	3	1
54	2	2	2	2	1	1	2	1	1	1	1	2	1	1	46	30	40	29	3	1
55	2	2	2	2	1	1	2	1	1	1	2	2	2	1	47	33	48	33	3	2
56	2	2	1	3	3	2	2	2	1	1	2	2	1	2	47	33	42	27	3	1
57	2	2	2	3	2	2	2	2	1	1	2	2	1	1	46	24	44	27	2	2
58	2	2	2	2	1	1	2	1	1	1	2	2	1	1	45	24	34	21	1	1
59	2	3	1	2	3	2	1	1	1	2	1	1	2	1	-	-	-	-	3	2
60	2	2	2	2	1	1	2	1	1	1	2	1	2	1	42	25	39	28	3	1

APPENDIX J

SUGGESTIONS FOR IMPROVING LEFT-RIGHT DISCRIMINATION AND READING ACHIEVEMENT

SUGGESTIONS FOR IMPROVING LEFT-RIGHT DISCRIMINATION AND READING ACHIEVEMENT

There are many ways in which children can be taught to discriminate left and right on their own bodies, for instance:

1. Games such as "Simon Says" may be played. In this game the child follows instruction prefaced by the words, 'Simon says'. For example, this instruction might be given, "Simon says, 'Touch your left knee with your right hand'."

2. Games such as the "Kokie Okie" may be played in which movements are made to music, the child moving various lateral body parts in response to the singing of the instructions.

To transfer the learning of the left and right sides of his own body to reading, teaching which incorporates a strong combination of the visual, auditory, kinesthetic and tactile senses may be carried out. This means that the child should be able to see, say and feel the letters and words, and may be accomplished thus:

1. To help the child establish his concept of the characteristics of each individual letter, the letters may be cut from sandpaper or felt fabric. The child should then be encouraged to handle the letters, to make their sounds and to put them together to form words.

2. Another alternative would be to trace out the letters in loose sand, making their sounds. The child could then proceed to trace out whole words, especially those involving the letters with which he may be having trouble such as b, d, n, u, a, c, e or others.

3. Word awareness might also be fostered by using the V.A.K.T. method of tracing out words with the index finger and then writing the words. The steps in this method are outlined below:

a. Look at the word, its beginning and its ending

b. Say it aloud

c. Spell it aloud

d. Trace the word with the index finger

e. Write it

f. Compare his written word with the word being studied

g. Repeat the process until mastery is attained.

These types of visual, auditory, kinesthetic and tactile learnings can be done at school under the supervision of the teacher or at home when an older person is available to help the child.

In order to ensure that children learn to discriminate the left and right lateral body parts of a person facing them and to attach the correct verbal labels to them the teacher should always raise <u>his</u> right or left hand when he

tells the pupils to raise theirs. This is especially important during physical education periods when the pupils are all watching the teacher demonstrate an exercise that involves using or moving toward one or the other sides of the body. If the teacher always raises his right hand when he tells the pupils to raise their right hand and his left hand when he tells the pupils to raise their left hand they will be more likely to learn to correctly discriminate between and correctly label the left and right body parts of a person facing them.

To improve the visual perception of children who have trouble differentiating between letters which are easily confused, such as 'b' and 'd', 'n' and 'u' and 'p' and 'q' and who are low in the visual-perceptual abilities of eye-motor coordination, position in space, and spatial relationships these procedures may be used:

1. Use exercises developed by Marianne Frostig to improve the above visual perceptual skills.

2. Print the letters which are easily confused, or with which the child is having trouble, on fine sandpaper with a felt pen. Draw arrows to show the correct direction, then have the children trace these with their fingers to learn the correct directions. After they have traced these letters have them print words using these letters and sound them out for reinforcement, for example, 'cab' and 'cad'.

3. Teach the child to use his thumb as a stabilizer to orientate his printing. That is, have him place his left

hand flat on the desk, use his right hand to make the letters, and teach him four directions in relation to his thumb:

A; away from his body

B: towards his body

C: away from his thumb

D: towards his thumb

The teacher would say and do the actions with the child to begin with and then gradually let him do them by himself. For example, to make a 'b' the steps would be to:

a. make a line towards the body (B), and

b. a curve away from his thumb (C) on the bottom half of the line, and to make a 'd' the steps would be:

a. make a line towards the body (B), and

b. a curve towards his thumb (D) on the bottom half of the line.

4. Use the Instructo Magnetic Manuscript Assortment (1969) to practice separating figure from ground by picking out letters which are easily confused and making words with them, always being careful to lay out the letters in a left-to-right sequence.

To ensure that left-handed children learn to read and write in a consistent left-to-right sequence the following suggestions are made:

1. The reader is referred to Hécaen and deAjuriaguerra (1964), pp. 91-93) for suggestions about circumstances under which children should be taught to use their left hand for writing. In general, they suggest

teaching children who exhibit strong left-handed tendencies to use their left hands for writing, taking care that they hold their hands in a natural position and move consistently in a left-to-right direction.

2. Left-handed children should be consistently taught to identify their own lateral body parts and to attach the correct verbal label for left and right to them. They should also be taught to identify the lateral body parts of a person facing them and attach the correct verbal labels for left and right to these body parts. Suggestions for accomplishing this were made earlier in this section.

3. Left-handed children should be given instruction in identifying letters if they show any confusion regarding letters which are easily confused, such as 'b' and 'd', 'n' and 'u' and 'p' and 'q'. Suggestions for doing this were made previously in this section.